Board of Scientific Advice for India

ANNUAL REPORT

FOR THE YEAR

1922-23

CALCUTTA
SUPERINTENDENT GOVERNMENT PRINTING, INDIA
1924

Price Re. I.

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question of soil acidity is of peculiar interest to tea producers and the Officers of the Indian Tea Association are making a detailed study of subject both in the field and laboratory. It is expected that the information obtained hitherto will be published shortly.

In the Punjab Lander has continued his experiments with the "Bara" soils of the Montgomery Districts. From investigations made on the soil and subsoil to a depth of twelve feet it would appear that the problem is not merely a physical one but that the chemical conditions also play an important part. Experiments conducted by this officer on the reclamation of Saline lands have shown that both scraping and flooding are capable of improving the land.

Miscellaneous.—The Hydrogen Ion concentration of soils and the variations induced under manureal treatments is under investigations by Carbery in Bengal and also by the Officers of the Indian Tea Association.

The Officiating Agricultural Chemist, Bihar and Orissa, is studying the action of Gypsum on the solubility of the soil constituents and its effect on the rate of percolation through a layer of soil which normally is almost impervious.

MANURES AND MANURING.

Field Experiments.—Norris has published a detailed review of the results obtained with regard to the yields and variations in the composition of the crops from a series of permanent manurial plots laid down at Coimbatore in 1909.

In South Bhagalpur the field experiments with green manures and superphosphate have shown residual increase in Nitrogen or P_2O_5 and it appears probable that annual application will have to be given if increased crop production is to be maintained.

Narasinha Iyenger reports that experiments in Mysore on the general manurial requirements of red soils and heavy paddy soils have indicated that nitrogen and P_2O_5 are required and that there is no response to potash manuring. He has also received confirmation of the conclusions previously drawn with regard to the manurial requirements of sugar-cane and areca palms in Mysore.

Farmyard and Organic Manures.—Lander has published the results of experiments designed to test the residual effect of Green manure in increasing the crop yields and finds that the effect is wearing off in some of the plots after four years. Carbery is investigating the fermentation of green manure in laterite soils in order to determine the conditions which lead to the greatest retention of the nitrogen.

In Madras an enquiry has been initiated the object of which is to obtain information regarding the bulk of manure obtained from one pair of cattle under different methods of storage and the manurial value of the same as indicated by analysis and croping trials.

The conditions under which artificial farmyard manure can be prepared efficiently and economically are being studied by the officers of the Madras

and Central Provinces department of agriculture and also at the Indian Institute of Science. This line of investigation would appear to be of great importance as it permits the employment of many waste materials for the formation of a valuable manure.

The Agricultural Chemist to the Government of Mysore has for several years been investigating the availability of nitrogenous manure and finds that sulphate of ammonia gives the best result. Of the oil cakes employed ground-nut and castor yield equal results whereas safflower cake is distinctly inferior.

The Officers of the Punjab Agricultural Department are making a detailed study of the effect of city sullage water on various crops.

Artificials Nitrogenous Manures.—Norris in Madras, has shown that when Calcium Cyanamide is applied to a soil it is rapidly and successively converted into urea and ammonia the latter being finally oxidized to nitrates. The condition leading to the formation of dicyanodiamide seem to be (1) the use of excessive amounts of nitrolin and (2) its uneven distribution. In either case alkaline conditions are produced which favour the production of dicyanodiamide which in turn appears to check nitrification.

Plymen has conducted experiments to test the value of Urea as a manure in comparison with such manures as Nitrate of Soda, Sulphate of Ammonia, etc.

Phosphate Manures.—Das at Pusa has continued his investigation into the determination of the " available " P_2O_5 of calcarious soils and found that extraction by a weak solution of K_2CO_3 gave values for available P_2O_5 which were not affected to any appreciable extent by varying amounts of $CaCO_3$. Applying the method to Pusa Soils with a known manureal history he finds that a differentiation is obtained which can be corelated with the manureal treatment and cropping value.

CROPS AND AGRICULTURAL PRODUCE.

Oils and Oil Seeds.—The content of essential oil in Cubeles, Kochoora root, Xanthoxylum rhetsa seeds has been examined in the laboratory of Professor Sudborough and an enquiry into the constituents of local ginger-grass oil has also been carried out. This same laboratory has also worked upon the composition of neem, punna, marote, rape, hongay, cashewnut, rocket, mustard and niger oils.

The Officiating Agricultural Chemist, Bihar and Orissa, has carried out experiments to determine the effect of varying manurial treatment upon the oil content of Castor Seeds.

Sugar Cane.—Clarke has published the results of the systematic trial on the field scale of the first series of Coimbatore seedlings. He found on seedling (CO 214) to be of considerable merit and of a type suited to U. P. conditions.

In Bihar and Orissa ripening tests of cane grown at Ranchi and Sepaya were carried out and the results have been prepared for publication.

Viswanath has extended the application of his refractometric method of testing cane in the field and finds that it yields a useful criterion for judging the ripeness of cane in varietal and manurial tests. In regard to after-ripening he finds the increase in sugar at the time of ripening occurs at the expense of the gummy and cellulose material of the cane.

Carbery has carried out manurial tests and finds that the shortage of lime is corellated with the high percentages of non-crystallizable sugar in the canes grown in the Dacca farm.

Sanyal at Pusa has been able to show that canes windrowed so as to be protected from rain are preserved in good condition when the same cane windrowed in the open rapidly deteriorated. This confirms his previous conclusions drawn from experiments carried out at Pusa and in the North-West Frontier Province.

Rice.—Charlton in Burma has devised a simple, convenient and cheap method of abolishing the nuisance due to the parboiling of paddy which is now in successful operation in several large mills.

Burma Beans.—By means of single plant selection of Burma Beans satisfactory results have been obtained in that several strains have been isolated which show a diminution of HCN content to the extent of about 30 per cent. In addition Charlton has investigated the effect of methods of storage on the variation in hydrolytic activity and the content of cyanogenetic glucoside and has published a note on the determination of Prussic Acid.

Warth has published a summary of his work on these beans.

Opium.—Annett and his co-workers has published paper on the estimation of codeine. Narcotine and Papaverine and on an investigation into the loss of Morphine content of powdered opium during storage. Their studies on the Enzymes of the Latex of Indian Poppy and the influence of Papaverine on the Optical activity of Norcotine in acid solution have also been published.

Work on the ash constituents of opium and on the method of isolating a purer form of the wax is being carried on and the study of the non-alkaloidal nitrogenous matters of opium has been taken up.

Tea.—The work of the Scientific Department of the Indian Tea Association has been largely concerned with investigations into factors influencing the quality of tea. (*a*) The study of the variation in tannin, N. K_2O and P_2O_5 by periodic analysis of the first leaf. (*b*) Variation in quality as determined by the tester and tannin content by analysis brought about by varying conditions of fermentation. (*c*) An investigation into the nature of tea tannin.

Miscellaneous.—Work in connection with the improvement of the cardamom crop at Sirsi is being studied by Sahasrabuddhi particularly from the soil biological point of view.

Lieut.-Col. R. McCarrison who is in charge of the Deficiency Diseases Inquiry carried out a number of feeding tests with Ragi (Eleusine coracana)

from the permanent manurial plots at Coimbatore and although the trials are incomplete very striking and unexpected results have been obtained. With the exception of the cattle manure plot which gives the best results, the plots receiving nitrogen have all given a grain having a lower food value than the non-nitrogenous plots. In conjunction with Norris an investigation into the causes of beri-beri is being carried out.

Viswanath has continued his investigation on the malting of cholam or juar and has shown that this grain is quite suitable for the preparation of malted foods.

Prof. Fowler of the Indian Institute of Science and his co-workers is continuing his investigation into the fermentation of cellulose material for the production of power alcohol and in this connection the possibility of utilizing the cob of Indian maize and waste coir dust have received attention.

Marsden has conducted an investigation on the bio-chemistry of coir-retting and has confirmed the conclusion previously arrived at that the process is due to organisms in the husk which are able to attack and destroy the " gum " and mucilage-yielding substances which bind the fibres together.

ANIMAL NUTRITION.

Mr. Warth has examined a considerable number of samples of Juar from different parts of India for their food value. Considerable variation in quality was found.

The same officer has determined the digestion co-efficients of nine typical concentrates and also for paddy straw. In regard to the latter fodder the average digestion co-efficients obtained for fibre and Nitrogen-free extract were 72 and 44 respectively whereas the corresponding averages found in American experiments are 59 and 46.

In regard to the nitrogen balance in five experiments out of six it was found that more nitrogen was excreted in the faces than was given with the straw, the exception being associated with an unusually high N. content of the fodder given. The conclusion arrived at is that small differences in the N. contents of the straw may cause very significant differences in nutritive effect.

In the course of work in connection with maintainance rations it was found that the nutritive ratio of the digested food was 1 : 16·2. This ratio is a very wide one but probably must be considered normal for bullocks in India.

Lander has determined the digestibility co-efficient of bhusa, gram, maize and sheesham leaves and the results are being prepared for publication.

The Agricultural Chemist, Mysore State, has carried out feeding experiments with calves and has shown that a mixed ration of bran and ground nut cake is better than one of either alone. Heifers fed on the mixed ration appear to come to maturity earlier than those fed on bran alone.

APPLIED CHEMISTRY

PART II.—FOREST CHEMISTRY

BY

J. L. SIMONSEN,

Forest Chemist, Forest Research Institute, Dehra Dun.

Essential Oils. (1) **Pinus longifolia.**—The terpene d—$\triangle^{3}$ carene obtained from the oleo-resin of *P. longifolia* has been re-examined during the year and the products formed on oxidation with potassium permanganate investigated. (Journ. Chem. Soc. Trans. 1923, *123*, 549.)

(2) **Pinus Merkusii.**—The turpentine from the oleo-resin of *P. Merkusii* has been studied and the constituents have been shown to be qualitatively identical with those present in the oil from the oleo-resin of *P. longifolia.* The quantity of *d*--$\triangle^{3}$ carene and *d*-longifolene present is small and the turpentine is of excellent quality. A paper on the subject is in the press. (The Constituents of some Indian Essential Oils. Pt. XII.)

(3) **Pinus Gerardiana.**—The turpentine from this rare oleo-resin has been examined, the oil consisting almost solely of d-L and d-β-pinene (Ind. For. Rec. Vol. IX, p. 345). The turpentines obtained from the oleo-resins of all the species of *Pinus* occurring in India have now been studied.

(4) **Pinus Excelsa.**—A sample of the leaf oil of *Pinus Excelsa* supplied by Col. C. R. Johnson of Abbottabad has been investigated. It possesses no economic value. (Ind. For. Rec., Vol. IX, p. 341.)

(5) **Boswellia serrata.**—A detailed examination of the oil from the oleo-gum-resin of *B. serrata* has been made. The main constituent was found to be *d-L*-thujene, a terpene not previously found in nature. (Ind. For. Rec., Vol. IX, p. 289.)

(6) **Andropogon Jwarancusa, Jones.**—The terpene present in the oil has been shown to be d-$\triangle^{4}$ carene, the second terpene of the carene group to be found in nature. (Journ. Chem. Soc. Trans. 1922, *121*, 2292.)

(7) **Cupressus torulosa.**—The oil from the leaves of *C. torulosa* has been examined (Ind. For. Rec., Vol. X, 1). The principal constituent of the oil was found to be *d*-sabinene.

(8) **Cympopogon Cæsius.**—Moudgill and Krishna Iyer have separated the oil from this grass and determined its constituents. (Perf. Ess. Oil Rec 1922, *13*, 292.)

(9) **Sandal Wood.**—Sanjiva Rau and Sudborough have published a valuable paper on the chemistry of Australian "Sandal wood oil" which is obtained from *Fusanus Spicatus* R. Br. (Journ. Ind. Inst. of Sc., Vol. V, p. 163.)

Fixed oils.—A number of important papers dealing with the utilisation of fixed oils have appeared during the year. They do not lend themselves to summarisation and reference should be made to the original publications. (The Relation between Iodine Values and Refractive Indices of some Hardened Vegetable Oils. Pt. 1 Sudborough, Watson and Athawale, Journ. Ind. Inst. of Sc., Vol. V, p. 47, Oil Splitting by Castor-seed Lipase Pts. V-VII, Sudborough and Watson, loc. cit. p. 119. Some West Coast Vegetable Oils. Joseph and Sudborough loc. cit. p. 133.)

The oils from the seeds of *Aleurites Montana* and *Salvia plebeia* have been studied at Dehra Dun.

Miscellaneous.—The chemistry of shellac has been decidedly advanced as the result of a valuable investigation by Harries and Nagel. (Ber. 1922, *55B*. 3833.)

Forster and Saville have commenced an investigation of the chemistry of gardenin, a crystalline constituent of the gum of *Gardenia lucida* first isolated many years ago by Shenstone.

Further work on the constitution of catechin has been published by Nierenstein and Freudenberg whose conflicting results are difficult to reconcile.

Marsden (Journ. Ind. Inst. of Sc., Vol. V, 157) has studied once more the question of utilising tamarind as a source of tartaric acid and also as a source of alcohol.

ASTRONOMY

BY

J. H. FIELD, ESQ.,

Offg. Director-General of Observatories.

Solar Physics—Researches in Solar Physics were carried on at Kodaikanal Observatory. The Observatory takes a prominent part in the world-wide programme of the International Astronomical Union. At a meeting in Rome in 1922 the Union allotted to India (Kodaikanal) the task of collecting from contributing observatories in other countries photographs of solar prominences and of the sun's disc taken in monochromatic ($H\alpha$) light and measuring them systematically. This work was begun regularly in January 1923.

Routine work.—Daily spectroheliographic records are obtained in calcium and in hydrogen light ; the routine work also includes visual examination of sunspots and faculae, sunspot spectra, and bright lines or displaced lines in spots and in prominences. The data resulting from the work are presented in the India Weather Review (Annual Summary), while for more technical purposes bulletins and memoirs of the Observatory are issued. Of the former 73 have appeared and of the latter 2 have been published.

Spectroscopic research.—The study of the displacements of spectrum lines in the electric arc when extraneous substances are introduced has been continued. The effect of additional substances on copper lines and also the effects on certain calcium lines have been tried, but no effect greater than that given by introducing sodium into a copper arc has been found. It is especially important to examine the effect on a long arc since many wave-length determinations have been made in the past without considering the effect of other substances present in the arc ; it has been found that the effects in a long arc are small, but sufficient experiments have not been made to establish the precise magnitude of the displacements. The displacements and appearance of spectrum lines in the arc and sun have been shown to follow very closely their behaviour in an electric field and hence it is concluded that the effects observed in the arc are the results of the electrical field in which the atoms find themselves in consequence of the electrically charged ions surrounding them. It is found that the field in the sun is of the order of 2000 volts per cm. less than that at the centre of the electric arc, and near the poles of the arc is 4000 volts per cm. greater than at the centre of the arc. Our knowledge of the ionisation in the arc is not sufficiently complete to enable any deduction to be made concerning the ionisation in the sun except that it would appear that the lower density in the sun is more than sufficient to compensate the increased ionisation due to the higher temperature.

It has been shown that in addition to the barium series previously found there are several spectral series showing the anomaly of changing the characteristics of the lines in the course of the series. The change is parallel to the behaviour in an electric field so far as evidence of the latter is available.

Mr. Evershed continued the study of the displacement of the sodium lines D_1, D_2 in the sun. After correcting for the effect of pressure in these two lines, he derived a mean shift of +0·017 A, whereas the Einstein displacement should be +0·012 A. Whilst the results tend to conform to the Einstein theory, further investigation is necessary before a definite judgment can be given. The speed of solar rotation deduced from the D lines was 1·937 km/sec. in close agreement with lines at a lower level in the sun, whereas a higher value was expected.

The prism spectrograph mentioned in the last report was again used by Mr. Evershed for determining the shifts in the spectrum of sunlight reflected from Venus. He concluded that the displacements were identical on the two sides of the sun facing the earth and turned away from the earth respectively. Mr. Evershed also compared the solar displacements of iron and cyanogen lines, obtained with this spectrograph, with those obtained previously with the grating spectrograph, and found that some lines did not show the same displacement as formerly, the maximum difference amounting to 0·005 A at the centre of the sun's disc and 0·008 A at the sun's limb.

An important feature of the year was the eclipse expedition to Wallal (W. Australia) led by Mr. Evershed. The main purpose of the expedition was to photograph the star field surrounding the sun, for determining the deflection of light by gravitation of the sun. In spite of elaborate preparations the results were disappointing chiefly on account of the defective coelostat which had to be used and also on account of the unusual faintness of the corona during the eclipse.

METEOROLOGY

BY

J. H. FIELD, ESQ.,

Offg. Director-General of Observatories.

Upper Air.—Flights of pilot balloons were continued daily at the upper air stations, Agra, Simla, Lahore, Quetta, Calcutta, Akyab, and with the co-operation of the Government of Mysore at Bangalore. Similar work at Peshawar was stopped as a temporary measure in the early part of the year.

At the Agra Observatory current work of out-stations was scrutinised and computations of upper air data were carried out.

Some headway was made in preparing for the resumption of meteorograph balloon flights.

The work in arrears was not cleared entirely up to date; completion might have been possible had it not been necessary in the winter to send a part of the computing and observing staff as "Meteor" parties to supply daily information about upper air currents to a number of Artillery Practice Camps. This work has been greatly appreciated.

The following papers in connection with upper air were published during the year :—

(*i*) Mean monthly characters of upper air winds deduced from the flights of pilot balloons at thirteen stations in India during the period 1910 to 1919—by J. H. Field.

(*ii*) On the seat of activity in the Upper Air—by P. C. Mahalanobis.

(*iii*) On errors of observation and upper air relationships—by P. C. Mahalanobis.

Several papers written in 1921, on Upper Air observations made during the years 1914-1919, were taken in hand for publication.

General Meteorology.—A paper "On exposures of thermometers in India," written in 1920 was published. It was based on experimental observations with a view to determine the comparative merits of the usual method of placing thermometers at observatories under thatched sheds and of other kinds of exposure like the Stevenson screen.

A paper on "A preliminary study of world weather" by Dr. Walker was prepared and is about to be published in the series of Memoirs on "Correlation in seasonal variation of weather."

It has been discovered that the westerly components of upper air winds at Agra at about the 6 km. level, as prevailing from the middle of September to the middle of October in the year, show close relationship with the precipitation in northwest India in the winter following. The matter is being followed up in view of its probable high value should the relationship be supported by the experience of a longer series of years.

TERRESTRIAL MAGNETISM

BY

J. H. FIELD, ESQ.,

Offg. Director-General of Observatories.

Alibag Magnetic Observatory.—The declinometer, the horizontal and vertical force magnetometers and variometers as well as the magnetographs were in use throughout the year.

In connection with the scheme of international co-operation for studying the effect of the total solar eclipse of the 21st September 1922 on magnetic elements special observations were taken at Alibag from the 19th to the 23rd September 1922.

The instruments and the routine work are described in the Annual Report of the Director of the Observatory for 1921 and also in the quinquennial volume of the data collected at Bombay and Alibag observatories for 1911-15.

The latter publication has been replaced by an Annual Volume and in future the more important of the magnetic data will be presented in it.

Magnetic Survey.—No. 18 Party (Magnetic) Survey of India.—The declination, horizontal force and vertical force magnetographs continued in operation throughout the year at the Dehra Dun and Toungoo observatories, and daily absolute magnetic observations were taken regularly by the observers in charge. The observatories were visited during the field season and observations of declination, dip and horizontal force, were taken for the comparison of instruments.

The Kodaikanal and Alibag observatories, under the control of the Meteorological Department, were also visited for the same purpose.

Observations at Repeat Stations.—Magnetic observations were taken this field season at the six repeat stations—Quetta, Karachi, Bina, Dibrugarh, Barrackpore and Waltair: these stations were visited to supplement the 5-yearly observations at all repeat stations in order to obtain accurate determinations of the annual changes in the magnetic elements.

Publication of the results of the magnetic survey.—The results of the observations at the observatories, repeat and field stations, reduced to the epochs 1909-0 and 1920-0 are in press and should soon be published.

Special magnetic observations.—In response to an appeal by Dr. L. A. Bauer of the Carnegie Institution of Washington, special observations in connection with the solar eclipse of the 21st September 1922, were taken at Dehra Dun, Toungoo and Kodaikanal. The three observatories were favour-

ably situated within the shadow belt of the eclipse. Declination, dip and horizontal force were observed at Dehra Dun, while at Toungoo and Kodaikanal only declination observations were taken.

Mean values of the magnetic elements at observatories in 1922, derived from readings excluding those when 'great disturbances' prevailed.

Observatory.	Latitude and Longitude.	Dip.	Declination.	H. F.	V. F.
	° ′ ″	° ′	° ′	C. G. S. Units.	C. G. S. Units.
Dehra Dun	30 19 19 N 78 3 19 E	N. 45 8·6	E. 1 43·2	0·32927	0·33091
Toungoo	18 55 45 N 96 27 3 E	N. 23 7·2	W. 0 29·7	0·39156	0·16717
Kodaikanal	10 13 50 N 77 27 46 E	N. 4 40·1	W. 1 58·7	0·37878	0·03093
Alibag	18 38 36 N 72 52 12 E	N. 25 5	E. 0 12·6	0·36967	0·17303

GEOLOGY

BY

DR. E. H. PASCOE, M.A., Sc.D., D.Sc., F.G.S., F.A.S.B.,
Director, Geological Survey of India.

Meteorites.—A meteorite is reported to have fallen at Quetta, January 1923, and to have set fire to a stack of *bhoosa*. The iron bands of the *bhoosa* were melted by the fire, and if a meteorite did actually fall, it became fused with this iron. A large quantity of ferruginous material was found after the fire had been extinguished, and proved to be a slag consisting largely of iron and silicate of iron, in which no meteoric texture could be recognised.

Palæontology.—Mr. LaTouche's Palæontological Index will be issued shortly. Various papers on the *Olividæ, Harpidæ, Marginellidæ, Volutidæ, Mitridæ, Fusidæ, Turbinellidæ, Chrysodomidæ, Strepturidæ, Buccinidæ, Vassidæ*, and *Columbellidæ* by the late Mr. E. Vredenburg have been published. The same writer is also responsible for an analysis of the Singu Fauna and a description of the zone fossil, *Ampullina* (*Megatylotus*) *birmanica*. Determinative work has been carried out also on the Triassic rocks of the Aden Hinterland, the Triassic rocks of Bikanir, the Nummulitic of the North-West Frontier Province and of Sind, the Tertiary of Burma, Assam and Persia, and the Carboniferous and Cretaceous of Tibet.

Geological Surveys.—The survey of the iron ore deposits in Singhbhum and the Feudatory States of Bihar and Orissa was continued, as was also the general systematic survey of the Central Provinces. In the Mergui district of Lower Burma a traverse was made from Tenasserim into Siam, in continuation of the general survey of the Mergui district. Coarse grained granite was found to occupy the main mass of the hill range forming the boundary between Burma and Siam. Some evidence was found of the retreat of the sea on the Siamese coast. Work in Tavoy was interrupted by the Mount Everest Expedition. The island of Elphinstone was found to coincide with the foci of the eruptions which took place during the deposition of the Mergui series. In the Southern Shan States the Loi-an coal-field was surveyed. Surveys in the Minbu and Pakokku districts were continued. The survey of the Betul district was practically completed. A further examination of Chitral brought out interesting facts in connection with the Devonian beds. The filling up of the blank on the geological map in the Hyderabad area was almost completed. Systematic surveys in the Siwalik foothills of the Punjab and in the Poonch Ilaqa were proceeded with.

Economic Enquiries.—Investigations were made and information recorded regarding the following minerals :—Aquamarine, arsenic, asbestos,

copper, manganese, garnets, graphite and sulphur in Chitral, bauxite in the Kolhapur State, lignite in the Ramnagar Raj, Tertiary coal in Mergui, Gondwana coal in the Southern Shan States, fire-clay and brick-clay in the Jubbulpore district, natural gas in Baroda, iron ore in Bihar and Orissa and the Northern Shan States, kaolin in the Ratnagiri district, mica in Kodarma, oil shales in Mergui, salt in Shwebo and Sagaing and in the Sambhar lake of Rajputana, and sillimanite in the Khasi Hills. Amongst engineering questions dam sites at Cherrapunji in Assam, on the Damodar and Barakar rivers in Bengal, on the Yunzalin river in Upper Burma and on the Sutlej in the Punjab were reported upon. The water supply at the Great Indian Peninsula railway near Itarsi and the general supply at Jubbulpore were taken up.

GEODESY

BY

LIEUT.-COL. H. McC. COWIE, R.E.,

Superintendent of the Trigonometrical Survey.

TIDAL OPERATIONS.

During the past year tidal registration by means of automatic gauges was carried out at the following ports:—

Aden, Karachi, Bombay (Apollo-Bandar), Bombay (Prince's Dock), Madras, Kidderpore, Rangoon, Moulmein and Port Blair.

All the tide gauges have worked satisfactorily, and there have been no serious breaks in the tidal registration.

All the tidal observatories except Aden and Port Blair, were inspected during the year and the gauges thoroughly overhauled and put into working order.

In addition to the automatic tidal registration at the nine ports named above, observations of high and low water on tide poles were taken during day light at Bhavnagar, Chittagong and Akyab, with the object of testing the accuracy of predictions which were based on tidal registration taken many years ago.

The Director, Inland Water Transport, Basrah, has continued to supply to this Department tidal observations taken on an automatic tide gauge erected at Margil by the Port Officer, Basrah. On the basis of these observations, data for the preparation of tide-tables for Basrah for the year 1923 were prepared and used on the tide-predicting machine. This machine was brought out from England and erected in the office of the Superintendent, Trigonometrical Survey, Dehra Dun, in October 1921. The tide-tables for Basrah for 1923 were published and forwarded to the Director, Inland Water Transport, the Port Officer, Basrah, and the Director of the Royal Indian Marine, Bombay, in September 1922.

The predictions of tides and preparation of tide-tables for Indian Ports as well as for Basrah from 1923 were undertaken entirely in India. The tables for 1924 will also be published shortly.

LEVELLING OPERATIONS.

During the season 1922-23 the following lines of precise levelling were run:—

A.—In the Punjab.

I. For the new level net.—

(*a*) Mithra to Khānpur forming part of the line 102 of the level net.

(*b*) Khānpur to Reti forming part of the line 105 of the level net.

In all 81 miles of levelling of high precision were completed on the "fore and back" system.

II. For the Sutlej Valley Irrigation Project.—

(*a*) Kasūr to Lodhrān.
(*b*) Ratta Tibba to left bank of river Sutlej *viâ* Luddakh.
(*c*) Kutabpur *viâ* Khān Bela to Adamwāhan.
(*d*) Lodhrān to N. W. railway bridge over the Sutlej.
(*e*) Khudiān to Lodhrān.
(*f*) From near Amruka railway station to Fāzilka.
(*g*) Fāzilka to Ferozepore (Revision of part of main line No. 57).
(*h*) Dingarh to Khānpur *viâ* Mithra, Reti and Chacharan.
(*i*) Chacharan to Khān Bela.
(*j*) N.W. railway bridge over the Sutlej to near Amruka railway station *viâ* Bahāwalpur, Marot and Walar.
(*k*) Kandhyawāla *viâ* Hāsilpur to left bank of the Sutlej.

This work was undertaken at the request of the Public Works Department (Irrigation Branch), Punjab, in order to furnish accurate benchmarks referred to a common origin, which would enable the Irrigation Engineers to co-ordinate all their cross levels throughout the entire length of the main canals and their distributaries. The total distance levelled on the system of "simultaneous double levelling" was 1,250 miles, of which half lay in the Bahāwalpur State. In addition to this, 13,750 miles of tertiary levelling were run over a previously demarcated area of about 2,045 square miles in British territory for the purposes of a detailed contour map.

B.—In the Bombay Presidency.

I. For the new level net.—

(*a*) Reti to Jacobabād, forming part of line No. 105 of the level net; about 137 miles.

II. For the Sukkur Barrage Project.—

(*a*) Shahpur to Mīrpur Khās.
(*b*) Jhol to Khipro.
(*c*) Mīrpur Khās to Uemarkot.
(*d*) Mīrpur Khās to Dadah.
(*e*) Mathli to Digri.
(*f*) Khipro to B. M. No. 7 of line C.
(*g*) Umarkot to Wungo.
(*h*) Wungo to Dadah.
(*i*) Dadah to Mathli.

This was undertaken at the request of the Public Works Department (Irrigation) in connection with the Sukkur Barrage Project. The total distance of 387 miles was executed by simultaneous double levelling

III. Ahmadnagar to Dhond.

This line was undertaken for the purposes of an investigation into the er ors of a level-circuit.

IV. For the Ghatprabha canal system.

(a) Sankeshwar to Kalādgi *viâ* Hukeri road, Yadvad and Mudhol.
(b) Hukeri road to Jodhatti.
(c) Jodhatti to Mudhol.
(d) Mudhol to Kudchi *viâ* Jāmkhandi.
(e) Kudchi to Jodhatti.

This work was undertaken at the request of the Bombay Public Works Department (Irrigation) in connection with irrigation in the Deccan.

The total distance levelled was 170 miles, carried out by simultaneous double levelling.

C.—In the Madras Presidency.

Gooty to Ongole *viâ* Banganapalle, Giddalur, Cumbum, Podili and Uppalapaud, with a branch-line to Atmakur *viâ* Nandyal.

The purpose of this line was to break up the large circuit Gooty-Arkonam—Madras-Bezwada-Gulbarga-Raichūr-Gooty. In the course of this work the heights of selected bench marks at Giddalur, Cumbum and Podili were determined with a view to investigating possible changes of level in an earthquake area.

This line was 220 miles in length, and was executed by simultaneous double levelling.

D.—In Burma.

I. For the scheme of the double embankment of the Irrawaddy.—

(a) Nyaungzaye to Yandoon, with a branch line to Maletto, along the left bank of the Irrawaddy and the China Bakīr.
(b) Yandoon to Kandin, along the Panhlaing, Kok-ka-wa and Hlaing rivers, and along the P. W. D. road.

II. For the correlation of the tide-gauge readings in the Irrawaddy Delta.

(a) Maubin to Bassein.
(b) Sagamya to Pantanaw.

Both (I) and (II) were carried out at the request of the Burma Public Works Department (Irrigation).

The total distance of 610 miles was done by simultaneous double levelling.

BOTANY

I.—BOTANICAL SURVEY

BY

C. C. CALDER, ESQ., B.Sc., B.Sc. (AGRI.), F.L.S.,

Offg. Director, Botanical Survey of India.

I. **Systematic.—Eastern India and Burma.**—Apart from the tours of the Director undertaken primarily in connection with Cinchona work but taken advantage of for Botanical purposes as well, no touring was possible during the year. Work in the herbarium has therefore been confined to collections already awaiting examination and to identifications of current consignments from outside collectors.

On the systematic side a great variety of study during the year calls for record. With the development of Botanical Schools in connection with Indian Universities and Colleges the range of study tends yearly to increase. Practically all the main groups of the vegetable kingdom now have their students and an increasing amount of attention is being given to many groups of plants which for one reason or another have received scant attention in the past. Thus the Algae, the Liverworts and the Fungi now have their taxonomists and a mass of literature on these as well as on the higher plants is finding issue in new botanical journals and papers.

Mr. Haines' further study of the flora of Bihar and Orissa and the Central Provinces has revealed the existence of the following four species new to science :—*Stereospermum angustifolium*, *Premna calycina*, *Leucas helicterifolia* and *Curcuma sulcata*. Full descriptions of these have been published in the Decades Kewensis section of the Kew Bulletin.

In Notes from the Royal Botanic Garden, Edinburgh, are published the last diagnoses by Prof. Balfour of a large number of Asiatic Rhododendrons. Seventy species in all are dealt with including some 29 from Burma and the North-East Himalaya collected by Messrs. Farrer, Kingdom Ward and Cooper, also a large number from China and Tibet collected by Forrest. Mlle Camus has described a new genus of the Bambuseae, *Neohouzeaua*, one species of which under the name *Teinostachyum Dullooa*, Gamble has been known from Bengal eastward in North-East India and in Burma. It is now reported from French possessions in South-East Asia. Another species belonging to the same genus, *N. tavoyana*, Gamble originally *Bambusa Helferi* has been redescribed by Mr. Gamble in the Kew Bulletin where he gives an accountof the

new genus and the effect of its adoption on the nomenclature of certain previously known Bamboos. An excellent local flora dealing with the vegetation of the Andamans from the forest officers' point of view has appeared in Mr. C. E. Parkinson's latest publication. The keys given furnish the field botanist with a ready means of identifying material as he goes along and the fuller descriptions in the body of the work supplement the information of the keys which are artificial. From Mr. Parkinson's collection in the islands Mr. Hutchinson has described a new species—*Orphea torulosa*—belonging to the Anonaceae.

In Burma the temporary dis-organisation caused by the transfer of the Cinchona plantations and the heavy work entailed in opening up the new area have prevented Mr. Russell and his assistants from doing as much field botanical work as might have been possible under more normal conditions. During a tour to the Mergui area late in the year the Officiating Director took occasion to collect and supervise collections. An additional mass of material over that collected in Tavoy is accumulating and will form the basis for future work on the systematic botany of the jungles lying between Mergui and the gulf of Siam.

The Algae of Bengal has been made the special subject of study by Prof. Bruhl and his assistants in the Biological Laboratories, Calcutta. Treatises on Indian bark algae and *Compsopogon* have appeared in the Journal of the Department of Science during the year; several species of bark algae new to science have been described while the distribution in Bengal of numerous previously known forms is being recorded.

The Polyporaceae of Bengal forms a subject of study for Prof. S. R. Bose; the results of his researches are being issued in the Bulletin of the Carmichael Medical College.

Northern India.—The most important botanical work having a special reference to this area published during the year has been Mr. Osmaston's treatise on the Forest Communities of the Garhwal Himalaya. The work is an oecological study of the tract and the conditions affecting the vegetation. The formations, associations and societies are all described and a series of excellent photographs illustrates the work.

The following new species of plants from Northern India have had their descriptions published:—*Acacia pseudoeburnea*, from Kumaon, Hardwar, etc., *Indigofera rubro-violacea* from the Chamba State and Kashmir; *Leptodermis kumaonensis* from Garhwal and *Astragalus aegacanthoides* from Kumaon.

Mr. W. B. Turrill has a paper on a question of nomenclature in the Cyperaceae raised in connection with his work on this group for the Flora of the Upper Gangetic Plain.

The Liverworts of the North-West Himalaya are the special subject of study of Prof. Kashyap and his school at the University of the Punjab. Amongst others Prof. Kashyap has interested himself in plant immigrants. In a paper read at the meeting of the Indian Science Congress he gives an account of foreign species establishing themselves about Lahore.

During the year Prof. Hallberg, late of St. Xavier's College, Bombay, made an expedition to the North-West to discover the distribution, abundance, times of flowering, etc., of the forms of *Artemisia* found over the area and known to contain santonin. So far as obtaining material rich in santonin was concerned the expedition failed, but a whole crop of questions on the reasons why santonin was not found have been raised. Quite an appreciable amount of the drug had previously been extracted from the same plant growing in the same area. The reasons why no santonin was obtained on this occasion are obscure, but the subject is of great economic importance and it deserves to be further investigated. As regards plants from the North-West the collections of the Botanical Survey are the richer by many thousands of sheets as the result of Prof. Hallberg's tour.

Western India.—Preliminary to a continuation of his work on the physiological anatomy of the plants of the Indian desert Prof. Sabnis is compiling a list of plants of the desert of Sind. Localities in Sind and the general distribution of the different species found are cited. In 1918 Prof. Saxton and Mr. Sedgwick published in the *Records of the Botanical Survey of India* an account of the plants of Northern Gujarat. Since then many additions have been made and these, with the intention of supplying information supplementary to the main account, have now been published.

In the same publication a further part comprising the families Labiatae to Ceratophyllaceae of Ethelbert Blatter's Flora Arabica has appeared.

A very handy account of the ferns of Bombay has appeared in Messrs. Blatter and D'Almeida latest publication on this group. The work is illustrated by figures showing the essential morphological details and in many cases the general appearance of the frond or plant is also given.

A new Indian grass—*Urochloa marathensis*—from the Bombay Presidency has been described by I. T. Henrard in the publication of the Van's Rijks Herbarium. The new species comes near *U. Helopus* described by Stapf but material is not sufficient to determine it as being identical. In the small amount of material available differences are evident and the author has thought these sufficiently marked to warrant, tentatively, specific distinction.

Southern India.—Mr. Gamble has described the following new species from the Southern part of the peninsula—*Torenia courtallensis*, *Didy mocarpus Fischeri*, *Toxocarpus Beddomei*, *Toxocarpus palghatensis*, *Legustrum travancorium*, *Brachystelma Bourneae* and *Brachystelma Rangacharii*—while Dr. Stapf in Hooker's Icones has fully described and figured new combination in *Cyrtococcum trigonum* and *Capillipodium glaucopsis* two new grasses. The most important botanical work dealing with the higher plants and connected with this division at present under preparation is Mr. Gamble's Flora of the Madras Presidency. Amongst the lower plants a new genus of Moss.—*Beddomiella*—founded on material collected many years ago by Beddome in the Nilgiris has been described by Mr. H. N. Dixon.

General.—Prof. P. F. Fyson has completed his study of the Indian Eriocaulons. His results are published in the Journal of Indian Botany and

in the reprint form a handy guide to the student in this rather difficult group of plants.

The Indian Ophioglossums are dealt with by Prof. I. D. D'Almeida of St. Xaviers' College, Bombay. The extreme variability of the individuals comprising the different species has been the cause of much splitting in the genus. Prof. D'Almeida has reviewed the characters which seem to him to merit consideration from the systematist ; the group is keyed re-arranged and described ; Indian distributions are dealt with and references made to the various collections on which the work is based.

The Fungi of Ceylon continue to receive the attention of Mr. T. Petch. Additions to the Fungus flora of the island are being published in the Annals of the Royal Botanic Garden, Peradeniya. All additions, no matter to what group belonging, are taken up. As most of the fungi are not endemic in the island but extend their distribution to the Indian Peninsula the work is of much value to students of the fungus flora of India.

A new colonial member of the Isokontae, a group of algae, collected in the inland fresh waters of Ceylon by Prof. F. E. Fritsch, is described by W. B. Crow in the Annals of Botany where the comparative morphology and systematic relationships of the new species are described.

Besides the above many works on systematic botany dealing with groups of plants, some numbers of which extend their distribution to India, have found publication during the year. The genus *Calendula* is dealt with by Hallier, the genus *Ptyssiglottis* by Moore, the Euphorbiaceae-Phyllanthoideae Phyllantheae by Pax and Hoffman and the Compositae-Hieracium by Zahn, the last two in the Pflanzenreich. Pfeiffer has a monograph of the Isoetaceae in the Annals of the Missouri Botanical Gardens.

Dr. Church has published an Introduction to the systematy of Indian trees, being notes arranged for students of Indian Botany at Oxford.

Sir J. C. Bose has studied the physiology of the ascent of sap in plants. Prof. Bruhl and his assistants have papers on Vitamines and an interesting and timely account of the new pond pest Eichhornia. Messrs. Dastur and Saxton have studied the vegetative methods of reproduction in certain plants and also the oecology of some plant communities in the Savannah formation.

A preliminary note on the life history of *Cedrus Deodara*, with, special reference to fertilisation and the structure of the prothallus has also been given by Mr. Saxton. Papers on the anchoring pads of *Gymnopetalum cochinchinensis*, flora prolification in *Nymphea rubra* and a note on an artifice of nector sipping birds are some of the results of Mr. Debbarman's observations during the year.

II. Economic.—The most important item under this heading continues to be Cinchona cultivation. Reference was made in last year's report to proposals for the transference of work to the Mergui District of South Burma. Conditions in the Tavoy area proved impossible and it became evident that a new location for Cinchona was inevitable. After very careful preliminary

investigation of the soil and climatic conditions in the neighbourhood of Tenasserim, proposals for a fresh start in this district were sanctioned and Mr. Russell, Superintendent of Cinchona Cultivation, with part of his essential establishment moved from Tavoy to fresh quarters situated in the foothills south of the Tenasserim Hevea plantations at Nyaungbinkwin. As conditions here seemed to provide all the essentials for Cinchona, work was started on a fairly extensive scale but not on such a scale as would prove ruinous if unforeseen events negatived the area as a source of supply of bark. By the end of the year some 1,500 'kamras' for seelings were in course of construction of which 150 were already carrying their stock awaiting transplanting; a mixed labour force was busy reducing the jungle to order while roads were being pushed through to link up Cinchona camp with the outside world and to get sufficient stores through in anticipation of the time when the rains would put an end to all but the minimum of communication. The original programme provided for a 'break' of 500 acres and clearing for a considerable part of this had already been done when the need for retrenchment forced a reduction to 250 acres. Sufficient seed for this minimum only was therefore sown and in far less time than they take to germinate in the Bengal plantations the seedlings were pushing their way through and looking the picture of health. It is, of course, much too early yet to claim success, but so far nothing has happened to cause apprehension or to create misgivings as to the ultimate results. Indeed all the evidence up to the present points strongly to the area being well suited for the purposes of a Cinchona reserve. In their early stages the seedlings were thriving so well that it seemed likely that second transplanting before being put out in permanent sites could be dispensed with. With a large number of seedlings this is what must now happen. Growth has been phenomenal and it has become impossible for lines to be built on a scale large enough and sufficiently quickly to accommodate all the seedlings. In the process of hardening the seedlings to the sun, methods which have never been deemed possible in Bengal have been successfully proved this year in Burma. The most encouraging feature of the whole scheme is, however, now available from analyses carried out on very young barks grown in the Tavoy area. The writer felt that there was a certain danger of the alkaloid content failing on account of the low elevation at which extensions had to go out. This would have been in accordance with experience gained from elevation tests in Java. No means of proving the point seemed possible until barks sufficiently old for analyses gave us data for Mergui but it was felt that an analyses of Tavoy barks grown on an average at much lower elevations than is the case in Bengal might afford useful evidence of a parallel nature.

If the Tavoy bark analyses now to hand can be taken as an indication of what may be looked for in Mergui, no more promising evidence of future success could be sought. These barks are twice as rich in quinine as Bengal barks of their age and species. When Cinchona trees grown under such adverse climatic conditions as have been experienced in Tavoy give at 2 years of age an alkaloid content of 4°/。 and at one year old between 2°/。 and 3°/。—percentages attained by Bengal trees at 4 to 7 years of age—it may be argued that

Cinchona planting in South Burma has one factor of prime importance in its favour. Climatic conditions have been almost ideal; the temperature in the hot weather goes a little higher than Cinchona likes, but it is not excessive and light shade planting should easily counter its effects; rainfall possesses none of the terrors it did in Tavoy and the soil seems capable of growing any crop. Under the careful supervision of Mr. Russell and his staff a very successful fresh start has been made.

Ipecacuanha, the only other crop at present experimented with, shows evidence of being much more amenable to ordinary methods of cultivation in Burma than has ever been found to be the case in the more trying climate of Bengal. When last seen in the nurseries the young plants had developed a nice bloom and looked healthy and robust. Seed for the extended cultivation of Ipecacuanha will be made available this year from Mungpoo. Meanwhile experiments on the extraction of the drug from the dried root are being carried out at the Bengal factory, the idea being to place emetine, the finished product, on the market.

IV. Publications.—During the year the following parts of the *Records of the Botanical Survey of India* appeared:—Vol. VIII, No. 4 being a continuation of the *Flora Arabica* by the Rev. Father E. Blatter, S. J., Vol. IX, No. 3 being *Additional notes on plants of Northern Gujarat* by W. T. Saxton F.L.S., I.E.S. In the Press at present are Mr. I. H. Burkill's account of the *Botany of the Abor Expedition*. A list of the more important extra departmental publications concerned with Indian Botany is appended to this report.

BOTANY

II.—ECONOMIC BOTANY

Part I.—Agricultural Botany

BY

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Imperial Economic Botanist.

The present report, which is limited to four pages of print, deals with the progress of Agricultural Botany in India during the year ending June 30th, 1923. Under these conditions, the best course would appear to be to limit this paper to an account of the more important results published during the year and to refer the student of Indian agriculture for further details to the various other annual reports and periodicals issued by Government which deal with the same subject but in greater detail.

The following publications contain a considerable amount of information on the improvement of crops :—

(a) *Review of Agricultural Operations in India.*—This is an annual report, prepared by the Agricultural Adviser to the Government of India, Pusa and deals, among other matters, with the distribution of improved seed in various parts of India. It also contains a classified list of papers on Indian agriculture published during the year.

(b) *Scientific Reports of the Agircultural Research Institute*, Pusa (including the Report of the Sugar Bureau). Copies can be obtained from the Director, Agricultural Research Institute, Pusa, Bihar.

(c) *Administration Reports of the Provincial Departments of Agriculture.* Bombay, Bengal, Madras, Central Provinces, United Provinces, Punjab, Bihar and Orissa, Assam and Burma. These are issued by the Government presses in these Provinces towards the end of each year and contain a general summary of the work of the Agricultural Department (including the farm reports) and also the annual reports of the Economic Botanists. These administration reports largely form the basis of the *Annual Review of Agricultural Operations in India.*

(*d*) *Proceedings of the Board of Agriculture in India.*—This contains the programmes of work in progress in Economic Botany as well as discussions on matters relating to the Agricultural Department as a whole. Copies can be obtained from the Agricultural Adviser to the Government of India, Pusa, Bihar.

(*e*) Many of the original papers on Agricultural Botany in India are published in the following periodicals : (1) *Memoirs of the Department of Agriculture in India (Botanical Series)*, (2) *Bulletins of the Agricultural Research Institute, Pusa and* (3) *The Agricultural Journal of India.* This latter contains classified lists of all papers published on Indian Agriculture. Copies of these publications can be obtained from the Director, Agricultural Research Institute, Pusa.

Cotton.—Mr. G. R. Hilson has published a detailed account in Pusa Bulletin 138 of his work on the measurement of the lint length, seed weight and weight of lint per seed of cotton. An improved type of cotton, known as Gadag I, for the Dharwar District of the Bombay Karnatak has been described by Mr. G. L. Kottur (*Agr. Jour. of India*, XVII, 1922, p. 347) who states that the staple is stronger and more uniform in length than the general crop. Seed for distribution is grown on the Gagad seed farm. Mr. Ram Prasad (Bull. 137, Agr. Research Institute, Pusa, 1923) finds that a relation between the length of the stigma and of the fibre is probable in some forms of the genus *Gossypium*. The author considers that this inter-relation requires to be tested further before it can be accepted as an absolute certainty.

Mr. P. S. Jivanna Rao, in the *Year Book of the Madras Agricultural Department* for 1922, has conducted a preliminary enquiry into the cause of bud and boll shedding in cotton.

The work of the Indian Central Cotton Committee has entered on a new phase. The Cotton Cess Act became law during 1923 and the Committee has now been provided with funds for the furtherance of research work on the improvement and testing of cotton. A number of grants have been made to Provincial Departments of Agriculture and towards the Institute of Plant Industry at Indore where particular attention will be paid to cotton. It has been decided to found six research studentships for the training of future investigators of cotton problems.

Sugarcane.—Mr. G. Clarke and his staff have completed a detailed study of various Coimbatore seedling canes when grown at the Sugar Experiment Station at Shahjahanpur (*Agr. Jour. of India*, XVII, 1922, p. 445). The majority of the seedlings proved to be of poor quality but one seedling of considerable merit, Co. 214, has emerged from the rigorous tests applied, as a type of cane suited to the conditions of at least one important sugar tract in the United Provinces. Mr. Wynne Sayer (*Agr. Jour. of India*, XVIII, 1923, p. 249) has given the results of various mill trials of selected Coimbatore sugarcane seedlings. The canes were grown under experiment station conditions at Pusa and were milled at Ryam factory near Darbhanga. A prelimi-

nary paper on the root systems of various varieties of sugarcane has been published by Rao Sahib T. S. Venkataraman and Mr. R. Thomas (*Agr. Jour. of India*, XVII, 1922, p. 381).

Wheat.—An account of the unit species met with in the wheats of Bihar and Orissa has been published by the Botanical Section, Pusa in the Memoirs of the Department of Agriculture in India. Some of these forms are likely to be of use in breeding as they are early, rust resistant and possess high grain quality. It is possible that one of the parents of Marquis, the celebrated Canadian variety which now covers large areas in North America, was one of these unit species.

Rice.—Mr. F. R. Parnell and his staff at Coimbatore have published a second memoir on the inheritance of characters in rice. The characters investigated were—the golden colouring of the inner glumes with modifying factors, the shape of the rice grain, the dwarf habit in the rice plant, and the colour of rice. Mr. R. K. Bhide (*Agr. Jour. of India*, XVII, 1922, p. 524) discusses the cause of sterility in rice flowers, a phenomenon which is frequently observed in Western India.

Physiology.—The rôle of plant physiology in agriculture was dealt with by Mrs. G. L. C. Howard in the Presidential address to the Botany Section of the Lucknow meeting of the Indian Science Congress. The paper has been published in full in the *Agr. Jour. of India* (XVIII, 1923, p. 204). Major W. R. G. Atkins, has published a preliminary paper on the hydrogenioni on concentration of some Indian soils and plant juices (*Bull. 136, Agr. Research Inst., Pusa*, 1922).

Water hyacinth.—The report of the Water Hyacinth Committee of Bengal has been published. Further investigations into new methods of eradicating the pest are recommended and the need of concerted action in the future is considered essential. To ensure effective action, some form of legislation is stated to be absolutely necessary. The Committee recommended to Government " that in view of the growing menace, scientific investigations be undertaken in the first instance into the life history of the plant and its mode of propagation and later on, into the practical methods for its check and the economic utilization of hyacinth in various ways so that the cost of operations may, to a certain extent, be recovered, and for this purpose a staff consisting of the following be employed for a period of three years—(1) a plant physiologist (2) a subordinate officer of the Agricultural Department and (3) an agricultural chemist. The total cost for these need not exceed Rs. 1,000 a month."

The coconut palm.—Mr. H. C. Sampson's book on the coconut palm has appeared during the year and includes interesting and valuable results on the root system of this tree. Mr. C. X. Furtardo has published a paper on the coconut inflorescence (*Poona Agricultural College Magazine*, XIV, 1923, p. 213).

Miscellaneous.—Messrs. P. H. Carpenter and H. R. Cooper have dealt with the factors affecting the quality of tea (*Quarterly Jour., Indian Tea*

Association, 1922, p. 44). Mr. T. D. Stock has published an account (*Agr. Jour. of India*, XVII, 1922, p. 577) of a primitive form of orange cultivation in one of the Northern Shan States of Burma and has made suggestions for its improvement. Mr. G. B. Patvardhan has printed a short ecological classification of the crops of Bombay (*Poona Agr. College Mag.*, XIV, 1923, p. 194). Mr. K. Kunhikannan describes in the *Agricultural Journal of India* the introduction of a tree from the New World known as the Mesquite or Azaroba (*Prosopis juliflora*). It appears that several full grown trees already occur in India in the neighbourhood of Madras.

BOTANY

II.—ECONOMIC BOTANY

Part II.—Forest Botany

BY

R. N. PARKER, Esq., F.C.H.,

Forest Botanist.

Oecology of Sal.—Work under this head which has been in progress for many years has now reached the stage at which the Botanical Branch can leave it. The results of the small scale experiments made by Mr. Hole during past years are being used on large scale regeneration works by the Silviculturist of the United Provinces.

Systematic Botany.—No progress has been made with the study of *Dipterocarpus* as the Systematic Botanist had to cancel his tour in Tenasserim and for the time being give up all botanical work in order to devote his time to the Minor Forest Products Exhibit of the Empire Exhibition (since abandoned). The study of *Acacia* group Caesia cannot progress further for want of certain type specimens which are probably only available in the Kew Herbarium. The study of *Acacia* group Eburnea depends upon procuring of further material from S. India and although local forest officers likely to be able to assist have been addressed, so far no specimens of any *Acacia* belonging to the group have been received. Thanks to the liberality of the authorities at the Natural History Museum, Vienna, the types of several species of *Berberis* have been sent to Dehra and returned after a drawing of them had been made. There are however still several type specimens in this genus to be traced. The confusion in this genus appears to be largely due to failure to understand the species proposed by the earlier botanists such as Wallich and G. Don the types of which are all still in existence. The bamboo *Teinostachyum Helferi*, Gamble which has been flowering recently in Burma and which evidently is not a *Teinostachyum*, has now been satisfactorily placed by Mr. Gamble in a genus recently described from Cochin China and it will in future be known as **Neohauzeaua Helferi,** Gamble in Kew Bull. (1923), p. 91.

Herbarium.—5,898 sheets were added during the year which is approximately double the number added in the previous year. The increase is almost

entirely due to the taking up of collections which have been lying unnamed for years some of them since the transfer of the Saharanpur herbarium to Dehra Dun. There is now very little of this class of arrears left.

Pathology.—The most interesting discovery during the year is that the numerous *Dalbergia Sissoo* trees dying near Dehra Dun are in all probability killed by *Polyporus gilvus*. Hitherto it has always been assumed that the deaths were due to the attacks of *Fomes lucidus* as the symptoms are similar and sporophores of this fungus have been found on *Dalbergia Sissoo* near Dehra. Last autumn however, probably as a result of the very heavy monsoon, numerous sporophores of *Polyporus gilvus* were found on dead and dying *Dalbergia*, sporophores of *Fomes lucidus* being conspicuously absent on this host though common enough on *Albizzia procera*.

Miscellaneous.—An enquiry into the tanning value of the fruits of the various forms of *Terminalia Chebula* as well as of closely allied species of *Terminalia* is being carried out in conjunction with the Imperial Institute. So far the results of the analyses have not been received from London. A paper on the Tung oil trees *Aleurites Fordii* and *Aleurites montana* in India has been prepared in conjunction with the Chemical Branch of the Institute and is ready for the press.

BOTANY

II.—ECONOMIC BOTANY

Part III.—Mycology

BY

W. McRAE, M.A., B.Sc., F.L.S.,

Offg. Imperial Mycologist, Agricultural Research Institute, Pusa.

Agricultural Research Institute, Pusa.—The work on species of Piricularia on various cereals and grasses was continued but no marked results were recorded. The sclerotial fungus has been proved by infection experiments to cause a disease of the rice plant. The disease begins on the leaves gradually spreads over the plant and causes its death. The fungus sown on sugarcane gave negative results so its connection with the fungus causing a similar disease on sugarcane is still in doubt though the two fungi in this sclerotial stage appears to be the same morphologically. From the field experiments to control smut (*Tolyposporium Penicillariae*) on bajra (*Pennisetum typhoideum*) and downy mildew (*Sclerospora Maydis*) on maize no definite conclusions could be drawn as the incidence of both diseases this year was slight. This is remarkable as the monsoon was a heavy one with few breaks so that the humidity remained continuously high yet the temperatures were uniformly lower and this latter fact probably accounts for the mildness of these diseases. Of various fungi isolated from wheat plants affected by foot-rot one a species of *Helminthosporium* was shown to be able to destroy wheat seedlings. This is possibly the cause of the disease but much work still remains to be done on the other fungi invariably found associated with it on affected wheat plants. Foot-rot is said generally to be found in those fields which have been sown early so it is possible that in areas where it causes much loss if the sowing were delayed till the cold weather has really set in there would be very little trouble. The study of the genus *Helminthosporium* was continued with special reference to the relationship between species on grasses and crop plants. The two plots laid down to determine the influence of sodium sulphate applied to the soil on the growth of jute and the incidence of disease showed marked differences. That which had received applications of sodium sulphate contained 1,399 plants weighing 533 lbs. and disease was entirely absent. The other plot which had no sodium sulphate applied con-

tained 1,342 plants weighing 220 lbs. and 744 of them were diseased. So promising is this result that a more extensive series of field experiments were laid down to test the accuracy and applicability of this treatment. The influence of the composition of the soil upon the incidence of disease in jute is being studied in cultures designed to test the effect of certain constituents of the soil on the growth of the fungus in culture. From members of the *Cucurbitaceae* that are grown as vegetables and that were rotting in considerable numbers strains of *Pythium* were isolated. The morphology of those from *Luffa acutangula L. aegyptiaca, Trichosanthes anguina* and *Lagenaria vulgaris* was studied.

The wilt caused by *Fusarium udum* on pigeon pea (*Cajanus indicus*) was severe this season. In the permanent manurial series of experiments the number of wilted plants has been recorded in three seasons in each of the two series. The averages of each of the three plots that receive superphosphate are—

4, 7·5 and 4 times in A series } the average of the 5 plots that get
6, 4·0 and 4 times in B series } no phosphate.

The averages of each of the 3 cattle manure plots are—

2, $2\frac{1}{2}$ and 2 times in A series } the average of the 5 plots that get no
1, 1 and 2 times in B series } phosphate.

The averages of each of the green manure plot are—

·36, ·23 and ·15 times in A series } the average of the 5 plots that get
·32, ·64 and ·23 times in B series } no phosphate.

It appears that those plots that get superphosphate carry an increased number of wilted plants that is significant and that the green manure plot has so small a number as to be significant. The cattle manure plots receive small but increasing doses from plot to plot and the number of wilted plants is highest in the plot that gets the largest dose yet the numbers of wilted plants are not so different as to appear to have significants beyond indicating a possible tendency that could be tested on plots that receive larger quantities of cattle manure. The fact that in the green manure plots to which superphosphate had been added the numbers of wilted plants are slightly higher than in the plots that get no phosphate seems to indicate that the superphosphate neutralises the depressing influence of the green manure on the incidence of the disease. Experiments are in progress to elucidate the effect of phosphate on the plant and the fungus and the effect of mineral phosphate as compared with phosphate in association with organic matter in cattle and green manure. This subject is of importance inasmuch as green manure associated with superphosphate increases the yield of other crops on the alluvium and that pigeon-pea is one of the crops in the usual rotation.

Madras.—Work on the following subjects was in progress. Diseases caused by species of *Vermicularia* on turmeric (*Curcuma longa*) cabbage and Bengal gram (*Circer arietinum*). Spores of *Vermicularia curcumae* were found to germinate after seven months and they are capable of infecting

cabbage, brinjal, *Datura*, knolkohl and *Withania somnifera*. Sclerotial masses were found on the rhizomes of turmeric especially on and near the scaly leaves and it is probably by means of these that the disease is carried from crop to crop. These sclerotia are capable of germination up to two years. The species of Vermicularia on cabbage was found to infect chilli, brinjal, ginger and Datura. That on Bengal gram and another on vegetable marrow are under study. Among new varieties of cane 15 of the cross between Kassoer and D 74 and 9 of the cross between Kassoer and Fiji B have proved so far resistant to smut. Soil infected with spores of *Sclerospora graminicola*, leaf shredding disease of *Andropogon Sorghum*, produced a crop of diseased plants indicating the means by which the disease is carried over. *Rhizoctonia* and *Gloeosporium* on *Carica papaya* are being studied and the latter is effectively checked by spraying with Bordeaux mixture. *Gloeosporium* on mango, and species of *Cercospora* on safflower, fenugreek, brinjal, pomegranate and *Solanum nigrum* were being studied. A systematic study of the *Diplodias* of South India has been made and a paper sent for publication. Spraying on a large scale was done on grape vines against mildew, on areca-nuts against *Phytophathora arecae*, on coffee against leaf-disease and black-rot, on turmeric against *Vermicularia curcumae* and on citrus against scab. In the areca gardens on the west coast Coconut trees that were dropping their nuts were found to be infected with *Phytophthora arecae*, the fungus that causes the rotting of areca-nuts. Infection experiments with pure cultures produced the same symptoms. Spraying the bunches of coconuts at the time of spraying the areca-nuts is being tried as a preventive. On the potato farm near Ootacamund 2,409 maunds of potatoes comprising 15 varieties were examined in order to select for planting good seed free from signs of fungus infection.

Manurial experiments against root diseases of tea caused by *Rosellinia arcuata* and *Hymenochaeta noxia* are being carried out and also spraying experiments on coffee against leaf disease (*Hemileia vastartrix*) and die-back, due to or associated with *Colletotrichum coffeanum* which usually is found along with leaf fall. On the unsprayed plots the ground was strewn with fallen leaves which invariably showed the disease. By shaking the bushes numbers of leaves dropped and many of the twigs were drying up. On the sprayed plots the bushes were well covered with leaves and the leaves remained on the bushes while there was very little die-back. This applied to both flushes of leaves. There is no doubt about spraying doing a great deal of good. Various sprays and different concentrations were used. This experiment will be repeated several times both with liquid and dust sprays to find the best and most economical method of carrying out the work in the conditions of the coffee districts.

Bombay.—The investigation of the storage rots of potatoes was continued and the Assistant Professor of Mycology visited Italy the principal source of seed supply for the Bombay Presidency to study the potato industry with a view to submit proposals for the improvement of the crop in the Presidency. The results of last year's work on the potato rots have been written up in 3 papers submitted for publication. A description of the four most common

potato rot fungi (two species of Fusarium, *Sclerotium Rolfsii*, and a species of Sclerotium) has been prepared and their temperature relationship studied. The work on cotton wilt with a view to discover or evolve a resistant variety has been carried a step further. Inoculations were made in the field and in pots. Of 431 plants of Wagale 4 per cent. were wilted, of 414 plants of Dharwar 2, 30 per cent. and of 419 plants of Kumta 39 per cent. The other varieties tried varied from 56 to 83 per cent. Wagale has withstood the attack remarkably well as it did last year. The experiment indicates that Kumta cotton contains types which resist wilt better than Dharwar 2, accordingly a number of resistant plants of this variety have been selected to test this. It was found that in the first generation of the cross between Dharwar 1 and a pure wilt resistant strain of Wagale resistance is dominant, at least during the greater part of the growing period. In pot experiments it was shown that the variety Broach Deshi Plant 6 is completely immune to wilt.

The leaf spot and blight of onions was found by infection experiments to be caused by a species of *Alternaria* which is a wound parasite. High temperature and humidity were found to be necessary for the spread of the disease. Field experiments showed that Goa and Nandore varieties of onions resist the disease to a considerable extent. The application of sodium nitrate in small doses at intervals combined with " rabbing " appears to be beneficial to the crop but Burgundy mixture had no effect in checking the disease.

The study of the mango inflorescence blight has shown that, though hoppers are the constantly associated with the blight, a mildew is also concerned. Preliminary observations made in the important mango tracts indicate that mildew is as important as the hoppers and in some cases it is the sole cause of the blight. Operations against the disease are to be started in the coming season.

Data are being collected on the diseases grouped under the term mosaic of which examples in Bombay are found on cardamoms, chilli, tobacco, potato, tomato, and *Raphanus sativus var. candatus*.

A disease of wheat associated with an alternaria and one of the betel vine associated with a Fusarium were under study.

Field experiments carried over several years have shown that smut (*Ustilago Eleusinis* Kulk.) of *Eleusine Coracana* is not seed-borne and that seed-treatment with copper sulphate is of no use. The results of spraying experiments against mildew on Cuminum were inconclusive as no disease appeared on the crop. The spraying campaign against Koleroga (*Phytophthora arecae*) was continued.

Bengal.—Several fungi associated with a disease of betel-vine have been isolated and their morphology studied. A bud rot of the areca palm was investigated but its cause is still obscure. Spraying was done against *Phomopsis vexans* on brinjal and against damping off on tobacco seedlings.

Central Provinces.—The efficacy of different preventive treatments against jowar smut was tested. The dusting method which appeared most

successful was that with copper carbonate dust. But the practical difficulty in the way of treating large quantities of seed with this dust was the want of a good type of a mixing machine. Lime sulphur and flowers of sulphur also were found to be effective. Of the steeping methods copper sulphate solution was found to be most effective. Formalin was found to be very inferior. Some work on cotton wilt was also done. Inoculations with cultures of *Fusaria* and *Cephalosporia* isolated from wilted cotton stems and roots invariably failed.

Assam.—Data with regard to the prevalence of a bud-rot of areca palms was collected and routine spraying was done on potatoes on the Shillong farm. Experiments were begun with a view to find a preventive for a disease caused by a species of Cephalosporium on rice plants. The soil was treated with various fertilisers and the seed with 3 per cent. formalin.

Indian Tea Association.—Some observations were made on the effect of various kinds of plucking on the susceptibility of the tea plant to attack of *Pestalozzia Theae Laestadia camelliae* and *Glomerella cingulata*. It was found that the more leaf taken off the plant the greater the susceptibility to these diseases. The life histories of a number of unnamed fungi recently found on diseased tea plants were worked out.

Most of the time was devoted to further experiments on the micro-organisms present in fermenting tea and considerable progress was made. Over fifty yeasts and a number of bacteria are under investigation.

United Provinces.—Work on the storage rots and field diseases of potato was continued. Very satisfactory results were obtained in experiments on storing seed and food potatoes at low temperature. Mosaic disease is found to occur widely, in considerable amount, in some districts the percentage being as much as 5 per cent. This disease greatly reduces the crop yield and is to a large extent responsible for the deterioration of the potato crop.

A serious nematode disease of wheat occurred in various parts of the province. This disease is under investigation. Work on the wilt disease of safflower was concluded and will shortly be published.

AGRICULTURAL BACTERIOLOGY

BY

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Imperial Agricultural Bacteriologist.

WORK AT PUSA.

Soil Biology.

Nitrogen Fixation in soil by "Non Symbiotic" organisms.—The work on this subject previously reported was continued and the following experiments were carried out :—

I. A large number of experiments was carried out to obtain further information as to the symbiotic relationship between algæ and nitrogen fixing soil organisms. Large differences in fixation were found to occur as the result of the influence of light and darkness upon algal growth ; thus in three months January to April the nitrogen fixed by a mixed culture of algæ and soil organisms was 1·19 mgms. in the dark and 3·50 mgms. in the light ; a second series run from 2nd July to 1st August gave 2·55 mgms. Nitrogen in the dark and 9·6 mgms. Nitrogen in the light.

Fermented residues of a green manure crop *Crotalaria juncea* were used to replace mannite as a source of energy in a pure culture of azotobacter ; 2 gms. of this material gave a fixation of 1·4 mgms. Nitrogen in 24 days 4th July to 28th July 1922. This would correspond in the field to a fixation of about 1·5 lbs. nitrogen to the ton of green manure in three weeks' time. Other experiments were made using a variety of cellulose decomposition products.

II. The effect of various organic residues and compounds upon nitrogen fixation in the soil.

Various green manures and crop residues were experimented with and large differences were noted in their suitability as sources of energy for nitrogen fixation by soil organisms ; thus Bajra (*Sorghum halepense*) gave 33·96 mgms. of added nitrogen whilst cowpea gave 12·03 mgms. and Asoka (*Polyalthia longifolia* leaves gave only 5·32 mgms. over a period of 3 months. These amounts were greatly increased by the introduction of fermenting organisms in the form of watery extract of cow manure. Previous fermentation of the organic residues considerably increased their apparent value as sources of energy for azotobacter and optimal periods of fermentation were found which varied with different materials. Thus maize which unfermented helped to fix 27 mgms. when fermented for one month before adding it to the soil, gave a nitrogen increase of 47 mgms. which was reduced to 34 mgms. when

fermentation had been continued for three months. Similarly fermented straw gave 19·3 mgms. Nitrogen as against 9·25 mgms. Nitrogen fixed in soil by unfermented straw over a 3 months' period.

III. Nitrogen fixation was found to occur in cowdung alone, and to be increased by some 15 per cent. by the addition of straw. Fixation also took place in a mixture of straw 15 gms. with 20 c. c. of a water extract of cowdung (1 gm. in 50 c. c.).

IV. Fixation of nitrogen in pure cultures of azotobacter was increased by small additions of nitrate ; (5 mgms. per 100 c. c. of culture solution) larger amounts inhibited fixation completely and resulted in reduction of the added nitrate. Artificial æration (by aspirated air) increased the amount of fixation from 8 mgms. to 9 mgms. per gram of mannite and at the same time greatly increased the growth of azotobacter.

Experiments were made to determine the relative rates of utilization of dextrose by various nitrogen fixing organisms, azotobacter, clostridium, B. radicicola and a mixed culture from cow manure, in liquid culture. The results are shown in the accompanying graph.

The effect of an indigenous rock phosphate on nitrogen fixation in pure culture by azotobacter was compared with that of Basic Slag ; the former had a distinct depressive action whereas Slag has a decidedly beneficial effect.

V. Nitrogen fixation was found to be active in river silt and a vigorous growth of algæ occurred in this medium in diffused light. More than double the quantity of nitrogen was fixed in the light than when the silt was kept in darkness (17·3 mgms. and 8·2 mgms. per 100 gms. silt) thus affording further evidence of the symbiotic relationship existing between the algal growth and that of azotobacter. Addition of mannite added some 4 mgms. Nitrogen to the amount fixed without it.

Eight varieties of algæ, distinguished by morphological characters under microscopic examination, were tested in pure cultures in symbiosis with azotobacter and gave varying results some negative (3) and some positive increases from 0·48 mgms. to 2·4 mgms. Nitrogen above the controls. In a rich garden soil showing algal growth the amounts of nitrogen fixed in four months were. In darkness 54 mgms. In light 77 mgms. With nitrate (5 mgms. per 100 gms. soil) in Light 91 mgms. per 100 gms. soil. Artificial æration in culture solutions containing algæ and azotobacter was found to depress nitrogen fixation to a considerable extent.

VI. Field experiments to determine the effect of various manurial and other treatments were commenced ; the results will be reported later.

The facts above recorded, although forming no doubt but a fraction of the greater mass of information which will be necessary for any adequate understanding of this important subject yet serve to indicate not only that progress is being made in the right direction, but that the possibilities connected with solution of the problem are fully as great as they appeared when that problem was first attacked. Briefly we know by observation that large amounts of

nitrogen can be added to Indian field soils by asymbiotic organisms, but nothing was known as to the causes responsible for the very wide variations in this amount in the same soils from year to year. The hopeful features of our results are that we have been able to obtain and establish similar variations under known and controlled conditions these latter not involving the utilization of economically impossible sources of energy such as sugar or molasses, but taking advantage of our previous work on fermentation of organic residues and thus relying on indigenous raw material alone. The symbiotic relationships with algæ are naturally of extraordinary interest in this country where these organisms are present in every soil, and it can be only a matter of time and further research along the right lines before we are able to indicate in what manner the management of the soil may be modified so as to increase the amount and rate of nitrogen fixation naturally taking place therein.

Nitrification.—Further work on the activation of nitrification of cattle urine was carried out with a view to conservation of its nitrogen content. A method of doing this, suitable for use by the ordinary Indian cattle owner, was worked out, consisting essentially of the use of a suitably prepared ærating filter bed made of broken brick or rubble, the passage of the collected and diluted urine through this bed resulting in the formation of nitrates and recovery of the major portion of the original Nitrogen content of the urine in this form.

The effect of composting with phosphates and sulphur upon the nitrification of various refractory sources of organic nitrogen such as Mahua cake (*Bassia latifolia*) was further studied in relation to the problem of solubilization of mineral phosphates by the same means. The general conclusion arrived at as a result of these experiments, in continuation of those of previous years, was that it is highly advantageous when dealing with the problem of the use of organic manures and residues, to make use of the method of fermentation under controlled conditions, already worked out at Pusa and recommended in the case of green manures.

The formation of nitrates and their vertical and horizontal distribution in soils under varying conditions of cropping and cultivation was further studied in field plots.

Green Manuring.—The results of the green manuring experiments on the Punjab Experimental area of the farm were made the subject of paper in the Indian Journal of Agriculture. The continued residual effect of large applications of fermented green manure was a marked feature of the returns and the effectiveness of such applications in conjunction with the use of superphosphate was also most noticeable. The most remarkable result, however, was that obtained by a putting in a fresh crop of green manure (*Crotalaria Juncea*) over the whole area five years after application of the original manurial and other differential treatment. The application of this green manure gave an immediate increase in the succeeding cold weather cereal crop over the whole of the plots, but the remarkable feature of the

returns was the obvious persistence of the effect of the original applications of superphosphate on certain plots, although these were made five years before. The underlying causes are naturally obscure but the importance of the result from an economic point of view alone, has led to the initiation of experiments designed to throw light on this interesting problem, with special reference to the possibility of bacterial intervention playing a considerable part in the matter. A field scale experiment confirmed the conclusions drawn from small plots in the previous season that in using Sannaj (Crotalaria juncea) as a green manure it might be advantageous to combine with this operation the separation of the stems as a source of fibre, the tops and leaves alone being buried in the soil. The green manure effect of such separation on the following *rabi* crop was found in some cases to be better and in all cases to be at least equal to that of the whole plant.

Bacterial decomposition of Organic residues.—Further study of this subject with special reference to Cellulose led to the isolation of a specific organism capable of dissolving cellulose under ærobic conditions but only in symbiosis with certain other soil bacteria of which several were found. None of these secondary organisms had any capacity for cellulose destruction either individually or in symbiosis with any other except the specific one first mentioned. The characters and relationships of these organisms will form the subject of a paper to be published in due course.

Solubilization of Mineral Phosphates.—Further work was done on this subject in view of the importance of bringing into use the large, but at present scarcely touched supplies of indigenous phosphates in this country.

By the use of cultures of sulphur oxidizing bacteria, these being watered into composts containing rock phosphate and sulphur, very great advances were made in the percentage of phosphate rendered soluble. In the previous report it was shown that by composting phosphate, cake, and sulphur, some 4·3 per cent. of phosphate was solubilized in sixteen weeks. By the addition of bacterial cultures this amount was increased to 66·9 per cent. with one culture and to 88·9 per cent. with another, in a period of only ten weeks. These results were obtained with indigenous rock phosphates; the same cultures acting on pure tricalcic phosphate solubilized 65 per cent. and 95·9 per cent. respectively. An interesting observation was made as to the beneficial effect of additions of gypsum to the sulphur phosphate compost. Such additions appeared to increase solubilization by improving the physical texture of the mass with regard to æration, this latter condition being a vital factor in oxidation of sulphur by bacterial action. A paper on this subject was written for the Indian Journal of Agriculture.

Indigo.—Work on this subject was necessarily curtailed as a result of the death of the Assistant Bacteriologist Mr. Petty who had been specially recruited to deal with industrial research problems.

Experiments on the use of pure cultures of indican hydrolyzing bacteria on a factory scale demonstrated the necessity of further work to ascertain the best methods of establishing such bacteria in the indigo vats in a concen-

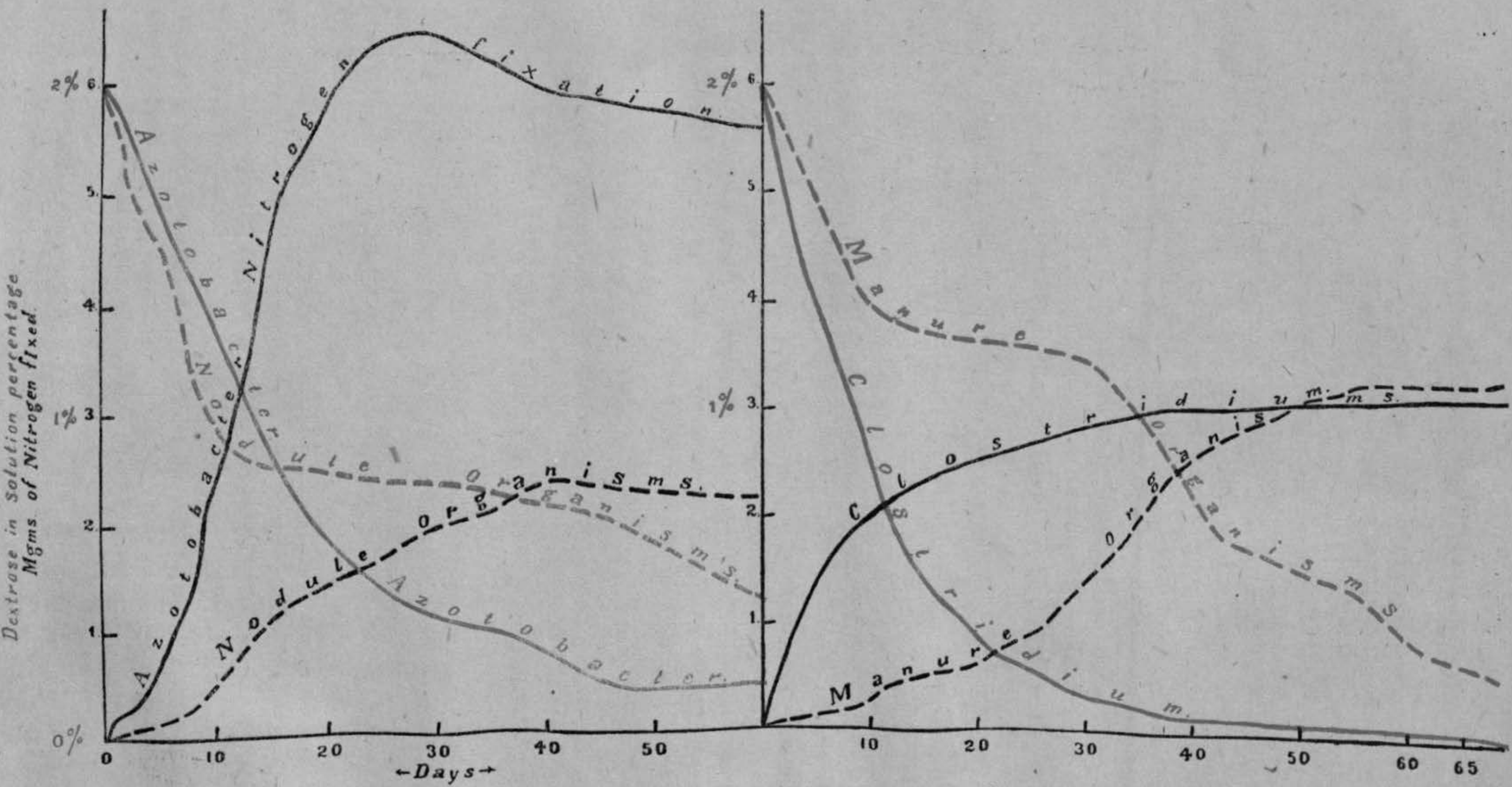
tration sufficient to secure the preponderance of their action over that of adventitious organisms unavoidably introduced with the water or the plant itself. In view of the closing down of the Indigo Chemist's Section and the abolition of the post of assistant bacteriologist in this section work on this subject must necessarily be relegated to a subordinate position. Some interesting observations were made on the losses occurring between steeping and beating; it was found that an interval of at least one hour may be allowed without appreciable deterioration or loss. A series of experiments on the neutralization of the fermented liquor with caustic soda before beating gave results which led to definite conclusions of practical value. In cases where fermentation and settling are normal no advantage is to be obtained by the use of soda; when, however, fermentation is poor, settling bad, and produce low, neutralization with caustic soda may be recommended as likely to result in improved settling and increased yield of indigo. The results of these experiments are detailed in an Indigo Publication now in the Press.

A considerable amount of work was done on the subject of sterilization of Indigo paste. Numerous bacteria were isolated from paste in a fermenting condition, some samples of which had been imperfectly sterilized in England with paranitranilin and others by heat. The thermal death point of these was determined and recommendations as to appropriate methods of sterilization by heat were made.

Bacterial infection of Sugar Mills.—Investigations were made of the character and specific action of various organisms found as contaminations in the cane juice of Sugar Mills in Bihar. A constant small percentage loss of sugar occurs in the mill, part of which is probably due to inversion during the short time of passage from the rollers to the evaporating plant. Although a large number of organisms was found, only a few of these possessed any considerable inverting power, and further work will be required to determine the practical significance of their presence in the cane juice in the mill. It appears probable, however, that some degree of antiseptic precaution in the mill would be attended with advantages.

E. C.—Further work on this antiseptic has now led to the standardization of a type of electrolytic apparatus specially designed for its preparation and made by Messrs. Mather & Platt of Manchester. This apparatus is specially designed for use in hospitals and can be run on an ordinary lighting circuit without any expert knowledge. As this preparation has a carbolic co-efficient of 3·9 and is made from entirely indigenous materials at a very low cost its use should allow of great savings in outlay on antiseptics whether for hospital or other purposes, and especially for sterilization of water as a preventive measure against cholera.

I read a paper on this subject before the Medical Section of the Indian Science Congress at Lucknow. Arrangements were completed to supply the Government of Bihar and Orissa with sufficient quantities of E. C. to meet the requirements of five of the principal hospitals in that Province until such time as these institutions should be in a position to produce their own supplies.



Azotobacter
Nodule organisms. } Black Lines indicate the amount of Nitrogen fixed (Mgms)
Red Lines Dextrose in solution (%)

Clostridium
Manure organisms. } Lines have the same significance.

The appointment of special officer to take charge of this production for the Province has been sanctioned by the Local Government.

Work in the Provinces.

Madras.—The premature fall of cotton bolls was found to be due to a rotting bacterium which was isolated and cultured. It is thought that inoculation occurs naturally through the intervention of two species of *Capsids*, and that the use of insecticides might be required to avert this.

Nitrogen fixing organisms were isolated from the nodular growths on the leaves of *Chomelia asiatica* and *Pavetta indica;* it is suggested that these plants would therefore be appropriate for use as green manure.

Megasse was shown to form a suitable medium for supplying energy to non-symbiotic nitrogen fixing organisms.

The malting properties of *Cholam* (*Andropogon Sorghum*) were examined and found to compare favourably with those of barley, maltose being the final product; proportionately large amounts of dextrine are formed in the case of *Cholam*. The differences observed support the suggestion that hydrolysis of starch in malting is brought about by two enzymes an "amylase" and a "dextrinase."

Central Provinces.—Attention has been principally directed to the practical application of biological analysis of soils to ascertaining the manurial requirements of selected types in the Province as judged by their specific biological reactions with various indigenous organic manures. This method gives valuable information of a practical nature.

FORESTRY

Part I.—Silviculture

BY

S. H. HOWARD, B.A.,

Silviculturist.

During the year under report the work of the branch could not be carried out on the lines recommended by the Silvicultural Conference of 1922 owing to the extreme shortage of staff and lack of money. It is hoped that this will be rectified in the near future but meanwhile new working plans are being made and old ones revised which perforce have to be based on data very little better than that on which the first plans were made. When such data are actually available, or are so nearly available that it requires very little work to fill the existing gaps, it seems a great pity that lack of staff to compile these results into a form in which they can be made use of, should necessitate important working plans being based on imperfect data.

Statistical work.—A very large number of plots have been measured by the various local silviculturists and the Central Institute and all results sent to Dehra Dun for working out. The United Provinces have helped greatly in working out many of their own results.

The most important matter during the year, however, is the compilation of the data for *Shorea robusta* (*sal*) into a yield table of three quality classes. This became an absolute necessity owing to the number of working plans for this species coming under revision in the United Provinces. The table has fundamentally changed the management and rendered possible a very large and perpetual increase in revenue estimated at 10 lakhs of rupees per annum by the Conservator of Forests, Working Plan Circle, United Provinces. The table applies to the United Provinces but will be applicable to other *sal* areas.

Volume and form factor tables and a general yield table for *sal* for other provinces will be undertaken during the forthcoming year.

The table is imperfect owing to the artificial timber limits necessary for such a compilation for such a country as India but it is hoped that within a very short time the outturn under practical conditions will be available. The table which at present is principally for Working Plan officers will then be of real help to the ordinary Divisional Forest Officer.

The other statistical work done on various other species has advanced to the stage that, given the necessary staff, yield and volume tables will be published in the forthcoming year for at least two more species.

The Sal (*Shorea robusta*).—Except in the matter of statistics the Central Institute has done little concerning this species as all such experimental work outside the seedling stage is now taken over by the provinces. Further experiments in the matter of keeping the seed till the break of the rains give promise of success. A natural regeneration experiment shows that a sheltorewod is probably essential in frost localities.

In the provinces natural and artificial work continues. The artificial regeneration of *sal* in suitable areas is a solved problem wherever labour can be obtained and where rain can be reckoned on at the time of seed ripening. Natural regeneration from seed is still largely unsolved though knowledge has advanced.

Afforestation.—The experiments in Zabarkhet have yielded results which are now almost conclusive. The problem is to afforest a blank in a *sal* forest with heavy grass and frost in winter *with no tending whatever during the rains* : with tending the problem would be simple.

The solutions in such a neighbourhood as Dehra Dun are : (1) Sow *chir* pine (*Pinus longifolia*) in lines ploughed through the grass 5 ft. or 6 ft. apart at the beginning of the rains. The seed should be red leaded before sowing. No further attention is necessary that year but a resowing may be necessary the following rains. During the winter the grass should be cut between the *chir* lines. The plants will in three or four years be about 4 ft. high. (2) Plant root and shoot pruned transplants of sissoo in holes 6 ft. by 6 ft. at the beginning of the rains. These pruned transplants should have a stem 2″ to 4″ long and root say 8″ to 10″. They will grow through despite the grass.

Either species is good but the *sissoo* suffers more from frost than the *chir* and on the whole the *chir* is preferable. Such afforestation areas must be fenced if there is much game. Pigs and porcupines do the most damage.

Experimental silviculture.—Work was continued on the weight of seeds and the results will be incorporated in the already existing bulletin on this subject.

A great deal of work was done on artificial regeneration with various species both entire and pruned transplants being tested, rains and winter transplanting and weeding versus non-weeding in each case. It is impossible to go into all the details and equally impossible to give general rules to which there are not many exceptions. Moreover the experiments are not by any means complete. Still the following are generally correct remarks in the case of the majority of the species tried.

Almost every species under whatever method or time of transplanting benefits greatly by weeding. In most cases weeding is essential to success.

Winter transplanting was almost always a failure whether weeded or not but even where a percentage of success was obtained it is very inferior to the ordinary transplanting at the beginning of the rains.

The results of entire transplants as compared with root and shoot cuttings are not complete. At present it appears that some species do better one way some another.

Some species are hard to transplant by any method.

Experiments were continued with bamboo regeneration (*Dendrocalamus strictus*). It was conclusively proved that a sure method is to plant offsets from one or two year old culms with rhizome attached and a well developed bud. These planted at the break of the rains gave 100 per cent. success and had culms 24 ft. long after two years.

The camphor work is completed and has been sent to press as a forest record though not actually published till after the close of the year.

FORESTRY

Part II.—Economic Forest Products

BY

R. S. PEARSON, C.I.E.,

Forest Economist.

1. **General Work of Administration.**—The year 1922-23 has been one of rapid expansion on the lines laid down in the last year's report, and although the activities of the Branch were much curtailed owing to financial stringency nevertheless progress has been satisfactory.

The Forest Economist had the major portion of his time taken up in organising and controlling the erection of the plant at the New Site, and at the close of the year under review the Sawmill, Wood Preservation Plant and Seasoning Kilns were practically completed; the Paper Pulp Plant and the Veneer Section were well on their way to completion; while some of the Timber Testing Machines were erected and others were working in a temporary workshop.

The financial condition of the country reacted, as everywhere, on the Economic Branch; and although much has been done there is no doubt that had Imperial and Upper Grade Assistants been appointed to the Sectional Officers, to be trained under their expert supervision, the results would have been considerably better.

The Forest Economist's touring was restricted, due to the continual supervision work at Dehra, to a visit to Calcutta in connection with the Exhibition of 1924; and to inspecting some experimental sleepers near Hardwar. Mr. Jollye, who held the appointment of Assistant Forest Economist until October 1922, when he went on leave and was replaced by Mr. Trotter, inspected the experimental sleepers on the Itarsi-Betul Section.

Year by year the number of enquiries increases both from Forest Officers, the Railways, Ordnance and Army Departments, Public Works, Commercial firms and private persons, so that the position now is that the staff, as at present constituted, cannot adequately cope with the work. When the Imperial and Upper Grade Assistants have been appointed, and the new Laboratories and Workshops are in full running order, this difficulty should be overcome.

The Trade Supplement to the "Indian Forester" which was started last year, has proved a greater success than was anticipated. It has now been enlarged and will gradually be developed.

II.—Experimental and Commercial Activities.

1. **Section of Wood Technology.**—The Wood Technologist, Dr. H. P. Brown, who came to the Institute for 22 months from Syracuse University just before the commencement of the year under report, has laid a fine foundation for the work of this section, which may be divided into two heads ; namely, routine and research work. Under routine work may be mentioned the identification of timbers. We receive constantly specimens of timbers for identifications, either in connection with a special enquiry from the provinces, or from commercial concerns, the railways and not infrequently for legal cases. The other portion of routine work consists in consulting with the other specialists on the staff as to properties of woods for a stated purpose which are best determined from their anatomical structure

The Research work in hand comprises :—

I. The preparation of keys for the determination of timber specimens in the field based on macroscopical features, as seen under a pocket lens

II. The same, based on microscopical characters for critical determination in the laboratory.

III. The preparation of a syllabus for use in teaching wood anatomy to the Provincial Class Students.

The progress made is that the routine work has been kept up to date : on the research side, mounts for microscopical work and photo micrographs have been prepared for approximately 175 species of timber. These latter consist of cross, tangential and radial microsections, of which photographs have been prepared for all the cross sections and 60 of the tangential sections at a 380 magnification. Another 125 species are in preparation for sectioning. No low power sections have as yet been prepared, but this side of the work will be started as soon as the hot weather begins, when photography will be held temporarily in abeyance till the rains break.

2. **Section of Timber Seasoning.**—The buildings for the experimental seasoning kilns at the new site have been practically completed, and the installation of the mechanical equipment has progressed to such a point that the kilns are ready to operate as soon as steam and water are available.

The experiments which had been under way for three years in connection with the air-seasoning of 53 important species of timber in different parts of India have been concluded, and the results have been published in "Indian Forest Records, Vol. IX, Part V." "Further experiments in the Air Seasoning of Indian Timbers and General Recommendations as to Seasoning Methods," by Mr. C. V. Sweet, Officer in Charge, Seasoning, with a chapter on "Damage to Timber by Insects" by Dr. C. F. C. Beeson.

An air-seasoning experiment on a commercial scale has been started in the Government Agent's timber depot in Calcutta, with eight important timbers from Bengal and the Andamans to determine (*a*) the length of time required for the air-seasoning of various timbers under moist climate conditions and (*b*) the amount of depreciation due to cracking, splitting, staining,

etc. Definite figures as to these items are totally lacking for Indian timbers, but are of primary importance in determining the relative economy of kiln and air-seasoning. Figures pertaining to kiln-seasoning will be accumulated at Dehra Dun when the experimental kilns are in operation.

A comprehensive scheme has been outlined by Mr. C. V. Sweet, Officer in charge Seasoning, and experiments initiated, to determine for the Government Gun Carriage Factory at Jubbulpore the most economical procedure to follow in the seasoning of their timber. The experiments are being carried out with the object of determining to what extent their present practice may be improved either by remodelling their present timber-seasoning godowns or by installing seasoning kilns. Figures are being accumulated to show which method of seasoning is most economical. The work at Jubbulpore affords an opportunity to accumulate data which can be got in no other way and which will be of general value to the Institute.

As a part of the general scheme a shipment of 3½ inch Sisso (*Dalbergia Sissoo*) planks and felloes was sent to Dehra Dun for kiln-seasoning. The timber was kiln-seasoned in two months' time to a point of equilibrium with the dry climate conditions of the Central Provinces with practically no loss whatever due to cracking, splitting, etc. In the past similar timber has been air-seasoned at the Gun Carriage Factory from 4 to 5 years, according to the present system ; and there has been considerable loss at the end of that time due to splitting. The very marked reduction in the seasoning time by kiln-seasoning will reduce their capital outlay in timber by lakhs of rupees.

An illustrated lecture on the importance of the economic value of timber-seasoning was given by the Seasoning Officer in the Indian Museum, Calcutta, under the auspices of the Bengal Chamber of Commerce and the Director of Industries. The timber firms of Calcutta were well represented at the lecture, and it is thought that the occasion served to awaken considerable interest in the work that is being started at Dehra Dun along this line.

Probably the most important factor governing the introduction of new species of Indian timbers into the market is the question of proper seasoning and grading. The suppliers and users of timber are reluctantly being forced to recognise the importance of adopting correct methods of seasoning their timbers by repeated failure and loss of trade. This being the case it is imperative that this section of our work be developed to the utmost. It is satisfactory to note therefore that this section has done most excellent work throughout the year under report and that we are now well on the way to tackling the most important of all utilisation problems, namely the proper seasoning of timbers in India.

The Seasoning Officer went to Rangoon to confer with the Seasoning Officer in Burma regarding the co-ordination of work and particularly the adoption of uniform grading rules to be used in judging the results of seasoning experiments.

3. **Section of Timber Testing.**—The four testing machines erected in the temporary workshops were in operation throughout the year, and the

work according to Project 1 which was prepared and sanctioned last year was taken up. Project No. 0, which comprises all special enquiries, such as spike-pulling tests on sleeper woods, impact and static bending tests on tool handles, etc., was also in force, and valuable data accumulated bearing on the various subjects. The foundations for all machines were put into the New Testing Shops, and two machines erected. As soon as the electrical scheme is put through the machines now in the temporary workshops will be taken down and re-erected at the new site.

The importance of timber testing may be gauged by enquiries made by persons and bodies with widely different interests and spheres of action. Thus Mr. Seaman, Officer in charge Timber-Testing, was entrusted with the work of rewriting the portion pertaining to timber of the Military Works Handbook, and submitted a list of grading rules and tables of working stresses to the Punjab Public Works Department. Similar information was supplied to the Superintendent of Workshops, Sarda Canal, to the State Engineer, Mayurbhanj, to the Bridge Department, Great Indian Peninsula Railway and to the Executive Engineer, Saharanpur. Tests were carried out on behalf of the Burma Railways, to determine the best size hole to bore in Pyinkado sleepers (*Xylia dolabriformis*) for spike-driving while bending tests on bamboo lance-shafts were carried out for the Inspector of Guns and Rifles, Ishapur. A long series of tests were carried out to find substitutes for hickory for oil-well sucker rods, and definite and satisfactory results obtained and submitted to the Indian Oil Companies concerned. Tests on hammer handles were carried out for the Government Wood Working Institute, Bareilly, and a further supply of new timbers has been received with a request that similar tests be carried out. A number of reports were prepared, the most important of which is an Interim Report on all results obtained under Projects No. 1 and No. 0, which is now in the press.

The total number of tests carried out during the year was as follows :—

	Mechanical.	Physical.	Total.
Project No. 0	3,012	1,804	4,816
" " 1	2,795	3,667	6,462
TOTAL	5,807	5,471	11,278

Routine tests according to Project No. 1 involving tests on green air-dried and kiln-dried specimens were carried out on Teak from Burma and the Central Provinces, on Sain (*Terminalia tomentosa*), Kanyin (*Dipterocarpus alatus*), Gurjan (*Dipterocarpus turbinatus*), In (*Dipterocarpus tuberculatus*), Deodar (*Cedrus Libani* Var. *Deodara*); and tests on green material only on Bakli (*Anogeissus latifolia*).

Tests according to Project No. 0 comprised :—

1. The completion of preliminary tests on Sucker rods.

2. The completion of preliminary tests on plugs for Stent concrete sleepers.

3. A series of spike-pulling tests on railway sleepers.

4. Impact tests on hammer and implement handles.
5. Comparative tests along routine lines of *Frenela rhomboidea*, *Eucalyptus globulus*, *Cullenia excelsa*, *Cupressus torulosa*, *Kayea assamica*, *Lagerstroemia tomentosa* *Pentace burmanica*, *Cupressus macrocarpa* and *Cryptomeria japonica*.

During the year a new type of spike-pulling meter and a modified type of compressometer were designed by the Timber Testing Officer. The former has only been calibrated and not yet tested, while the latter after calibration has been put in use and found to be most satisfactory.

4. **Section of Minor Forest Products.**—The scheme to establish an industry in *Boswellia serrata* gum oleo-resin in the Bombay Presidency is still under consideration, and the work in this connection is being actively prosecuted. The up-to-date steam distillation plant for producing "Rosha oil" from *Cymbopogon martinii* grass in the Central Provinces, which was erected 2 or 3 years ago, has proved a success and may now be considered an established fact.

It is to be hoped that the appointment of an Officer to take charge of the office of Minor Forest Products will not be indefinitely postponed, as a richer field for enquiry and one more likely to yield sound commercial results would be difficult to find.

5. **Section of Wood Utilisation.**—Owing to the Seasoning Kilns, Wood Workshops and Testing Laboratories not being in full working order and the veneer plant not being erected, the number of experiments carried out was restricted to those which could be dealt with in the Testing Laboratories and by sending the timber elsewhere to be dealt with. The rough-cut specimens to be tested for bobbins by a large manufacturing firm in England have been reported on, and generally speaking the results are not encouraging. The report, however, has not yet been fully considered, as it has only recently been received. The tests carried out to find woods suitable for sucker-rods definitely showed that *Terminalia tomentosa* and *Heritiera minor* can be used as substitutes for hickory. Much interest has been taken and a large number of enquiries received in connection with match-making, owing to the high import duty now imposed on foreign matches. Most of our Indian timbers which have been tried have proved to yield poor quality splints. It is possible that better results may be obtained with these woods by using a slicing instead of a rotary machine.

6. **Section of Wood Preservation.**—The work of years at this subject is now bearing fruit, as the Railways have accepted the use of treated sleepers, while some systems have put up treating plant and other are actively engaged in schemes to do so. The North Western Railway is treating large quantities of sleepers with creosote in open tanks, and has erected a large pressure plant, which should soon be in operation. The Assam Railway Trading Co. has also erected a pressure plant and sleepers are being treated in open tanks in Southern India, while several other Railways have projects on hand to treat their sleepers themselves.

There remains a very important side to this enquiry which has still to be undertaken, and that is to carry out absorption tests and to determine the most economic method of treating the many species of Indian timbers mechanically suitable but deficient in durability unless treated for sleeper work. The experimental pressure plant purchased some years ago by the Forest Research Institute has now been erected, tested and found to answer the purpose admirably. It is so designed that timber can be treated by all well-known methods except the Card Process. The difficulty is that due to financial stringency no Wood Preservation Officer has been appointed, though the results which could be obtained even in a short period of time would certainly be valuable out of all proportion to such an officer's salary. In the meantime provided an Assistant can be appointed, the Forest Economist hopes to run through a little of the most urgent work.

Two records of experiments covering a period of over 10 years were issued during the year, the first Indian Forest Record Vol. IX, Part I, 1922, "Results of the Antiseptic Treatment of Sleepers" and the other Technical Paper No. 231 published by the Railway Board, entitled, "Antiseptic Treatment of Sleepers in India" both reports being by the Forest Economist.

7. **Section of Paper Pulp.**—Mr. W. Raitt was in charge of this section throughout the year and was chiefly engaged in supervising the erection of the complicated experimental pulp plant, with a digester of approximately 15 cwt. capacity and an up-to-date 36 inch experimental paper machine. The necessary crushing and chopping machines are also being installed. The plant is now practically erected, with the exception of the water and steam connections.

At the request of the Bihar and Orissa Government the Officer in charge, Paper Pulp, visited the Cuttack and Angul forests with a view to determining the feasibility of starting a bamboo pulp scheme in that locality. The subject was carefully worked out and a detailed report submitted to the Local Government which indicates a promising commercial proposition.

At the request of the Sirmoor Durbar a local enquiry was made into the pulp making resources of the State and a report presented to the Durbar.

A considerable amount of laboratory work was carried out in connection with bamboo and grasses, which will be of great value when large-scale experiments are started with the new experimental plant now erected on the New Site. A number of routine enquiries were dealt with during the year.

8. **Section of Tans.**—Mr. Pilgrim was in charge throughout the year, and was stationed at Mergui in Lower Burma, to carry out an exhaustive enquiry into the tan-stuffs of the Mangrove forests of that locality. He has now completed the work and is engaged in writing up his report. He also completed a valuable report on the Myrobolams of the Central Provinces and Terminalias of Burma, which have now gone to press. He has also issued a pamphlet during the year on the tanning properties of certain Lagers trœmias in Burma, which appeared in the "Indian Forester."

ZOOLOGY

I.—GENERAL ZOOLOGY AND PHYSICAL ANTHROPOLOGY

BY

N. ANNANDALE, C.I.E., D.Sc., F.A.S.B.,

Director, Zoological Survey of India.

Tours.—The following tours were undertaken by members of the department :—

	Days.
To Southern Shan States from the 1st April to 11th April 1922, Dr. S. L. Hora	11
„ Barkuda, Chilka Lake from 2nd June to 7th June 1922, Dr. S. W. Kemp	6
„ Punjab Salt Range from 24th June to 17th August 1922, Dr. S. L. Hora	55
„ Lucknow from 7th January to 14th January 1923, Dr. N. Annandale	8
„ Barkuda, Chilka Lake, from 19th January to 24th January 1923, Dr. S. L. Hora	6
„ Barkuda from 19th January to 24th January 1923, Dr. N. Annandale	6
„ Buldana, Central Provinces, from 10th February to 25th February, 1923, Mr. H. S. Rao	16
„ Barkuda, Chilka Lake, from 16th February to 20th February 1923, Dr. Baini Prashad	5
„ Barkuda, Chilka Lake, from 16th February to 20th February 1923, Dr. N. Annandale	5
„ Cherrapunji from 15th February to 6th March 1923, Dr. S. L. Hora	20
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Publications.—The following publications have been issued during the year :—

"Records of the Indian Museum," Vol. VIII, Part 13.

"Records of the Indian Museum," Vol. XXI, Parts 2—3.

"Records of the Indian Museum," Vol. XXIII, Part 1.

"Records of the Indian Museum," Vol. XXIV, Parts 1—4.

"Records of the Indian Museum," Vol. XXV, Part I.

"Memoirs of the Indian Museum," Vol. V, No. 10.

"Memoirs of the Indian Museum," Vol. VII, No. 4.

Library.—The total additions number 1911. Of this 658 books and parts of periodicals were purchased and the remainder received in exchange and by presentation.

The following additions may be specially mentioned :—

"Handbuch der Biologisch Arbeitsmethoden."

"Journal of Animal Behaviour."

"Psychobiology."

"Journal of Comparative Psychology."

"Reise in Ostafrika."

"Animaux Venimeus" by Marie Phisalix.

All the above were purchased.

Collections.—As time goes on and the collections increase it becomes more and more difficult to exercise proper supervision over them with the present totally inadequate staff. Discoveries of losses due to petty thefts of spirit and bottles in former years are constantly being made.

Galleries.—I have nothing to add to my report of last year under this heading except to state that the Tibetan collections have been arranged by Mr. J. van Manen, through whose kind assistance many valuable additions have been made in this section. A case containing Brahui musical instruments from Quetta has also been set up.

ZOOLOGY

II.—ECONOMIC ZOOLOGY

Part I.—Agricultural Entomology

BY

T. BAINBRIGGE FLETCHER, R.N., F.L.S., F.E.S., F.Z.S.,

Imperial Entomologist.

I.—Work at Pusa.

This has followed on the lines of previous years and a more complete account is given in the Annual Report of the Imperial Entomologist.

Work on the borers of sugarcane and other gramineous plants has been continued but no further novelties were met with. Insect pests of crops have been observed and dealt with as occasion arose. Investigation of life-histories of Indian insects has been continued and their early stages described and figured.

Work on Pathological Entomology has been continued mainly with reference to Veterinary Entomology, with regard to which there appears to be need of a publication dealing with the insect pests of domesticated animals in India and considerable progress has been made in the preparation of a book on these lines. Special attention has been paid to Tabanidæ, from both the systematic and biological aspects, and further work has also been done on the biology of the local Culicidæ. In collaboration with the Imperial Bacteriologist, experiments were commenced at Muktesar on the cyclical transmission of the rinderpest organism.

The usual routine work has been continued with Bees and Lac and in connection with the latter the damage done to the lac crop by *Eublemma amabilis* has been under investigation.

The usual steady progress has been made, as regards the Insect Survey, with the increase, arrangement, and identification of the Pusa collection of Indian Insects, which is now a large and important one, and is increasingly taken advantage of by the Provincial Staffs and other workers on Indian Entomology for the identification of their material.

The second and third parts of the Catalogue of Indian Insects on Culicidæ and Bombylidæ, respectively, have been issued during the year and other parts are under preparation.

The Board having ordered the separate publication of the bibliography heretofore included in this Report, the list of literature on Indian Entomology, prepared for the year 1st July 1920 to 30th June 1921, was extended to 31st December 1921 and issued as Pusa Bulletin No. 139. A similar list of literature for the year 1922 has also been prepared and is now in the press.

II.—Work in the Provinces.

Madras.—The investigation of the bionomics of *Platyedra gossypiella* and *Pempheres affinis* was continued, especially with reference to the checking of the effect of the enforcement of the Pest Act control of the insect pests of Cambodia cotton.

The trial of the control of *Schœnobius incertellus* (*bipunctifer*) by the method of seedling selection was continued at Samalkota.

An investigation was begun of the bionomics of *Calocoris angustatus* on *Cholam*, especially with reference to control measures.

An investigation of a disease in Betel-vines around Coimbatore—probably due to the attack of the Root-knot Eel-worm (*Heteroderes radicicola*)—was taken up and manurial experiments are under trial towards the control of the disease.

The attack of fruit moths, including three species of *Ophideres*, was investigated in an orchard in Kistna district and remedial measures tried.

A serious attack of *Nephantis serinopa* on coconut at Mangalore was attended to by the combined efforts of the Entomological, Agricultural and Revenue Staff from June 1922 to December 1922. From 1st January 1923, the Pest Act has been brought into operation by Government for eradicating this pest and is being enforced.

Experiments towards the control of the mangohopper were taken up and conducted in certain villages in the Chittoor district but the results have not been as satisfactory as could be desired. It is proposed to repeat them in the coming year.

A fair amount of systematic work was done in Capsids, Braconids, Coccids and Anthomyiads.

Bombay.—Under the Sir Sassoon David Trust Fund investigations were carried out on stem-borers in *juar* at Surat, the borers found being *Chilo simplex*, an Anthomyiad and *Sesamia inferens*. Of these Chilo was found to be the worst pest, attacking up to 50 per cent. of plants, whilst *Sesamia* ranged up to 26 per cent. and in the case of the Anthomyiad the attack was about 15 per cent. in some plots. *Juar* sown at Surat from the middle of July to the middle of August was less attacked by borers in the initial and middle stages of the crop and resisted borer attack better during the ripening stages, in comparison with earlier and latter sowings. No varieties of *juar* were found to be immune from attack. All three borers were found to breed in sprouts from stubble left in the ground, but breeding is stopped if the stubble

is ploughed up and exposed to the sun's heat for about two weeks in the summer, Larvae of *Chilo* are able to survive in *Kabdi* stalks stocked for cattle fodder but are killed by chaffing the stalks. Further trials were made with *Amsacta moorei* by attracting the moths to light-traps on first emergence and by dusting attacked crops with a mixture (1 : 20) of Paris green and lime. Fumigation with carbon disulphide of seeds attacked by beetle pests was also done.

In the Konkan work was done on crabs injurious to the rice crop and on the protection of cruciferous seedlings from flea-beetles.

At Poona some attention was given to the Citrus White-fly (*Aleurocanthus spinifera*) and to *Ophideres* spp., the moths of which attack ripening fruits. Work was also done on the parasites of *Chilo simplex*, of which one was found attacking the egg, three the larva and two the pupa.

Central Provinces.—Aleyrodids, particularly on low-growing weeds, are being studied. One Aleyrodid (unidentified), found commonly on *Tephrosea purpurea* (a leguminous weed) was reared up to three generations from 12th July 1922 to 1st October 1922, each generation occupying about 25 days. The female of this insect deposits one small oval egg in a little depression on the leaflet of the weed; numerous such depressions are seen on one leaflet and thus it presents a very curious appearance.

Work on *Chilo simplex*, the common *Juar* borer, is being continued. During the year six varieties of *Juar* were sown to find out (i) Percentage of attack, (ii) Time and stage of the borer entering the resting period, (iii) Place where a borer rests.

Varieties of *Juar*.	(i) Percentage of Attack.	(iii) HIBERNATION IN LARVAL STAGE.	
		Stubbles.	Stalks.
1. *Sundia*	67	10	45
2. *Detha*	41	12	65
3. *Saoner*	57	10	72
4. *Lamkansi*	36	13	52
5. *Chapti*	40	13	54
6. *Ramkel*	25	8	49

(ii) Living pupæ were found as late as October, but from November onwards only larvæ were found.

Xanthopimpla nursei so far appears to be a common parasite on *Chilo simplex*. In the laboratory the last emergence of the parasite was in the first week of November and one parasite emerged in May 1923 from larvae obtained from Chhindwara.

Bengal.—During the egg-laying period of the Mango Weevil (*Cryptorrhynchus gravis*) in 1922 careful examination of the mangoes under observation on the Dacca Farm, was made, and the affected trees noted. Besides bagging, plucking of the young fruits with eggs was done, as far as possible, to reduce the pest to a negligible number. Also in 1923 examination of young fruits was done as usual but no fruit was found affected in any stage, although the pest was observed in numbers this year on fruits at Kaorainbazar close to the Dacca Farm, where the fruits are brought for sale from surrounding villages.

A big private mango garden at Dhanbari (Mymensingh), in which the fruits of some trees were formerly attacked by the mango weevil, was also under observation this year. In October and November last the garden was cleared of jungles and the branches killed by borers (*Rhytidodera*) were cut down. The circular areas round the trees were also hoed up. Besides, early in the season when small fruits were formed, a large number of the fruits of previously infested trees and those which fruited early were enclosed in small cloth bags. The exposed mangoes were also under observation from the egg-laying period till the end of the mango season but no fruit was found affected this year. So clean culture and above all consumption of the young fruits of trees detected with eggs on fruits seem to be most essential in keeping off this pest. A note on the pest, with a plate, is being published in the *Bengal Agricultural Journal*.

A serious outbreak of *Agrotis ypsilon* in the Naogaon *ganja mahal* was reported. The place was visited and the cultivators were asked to handpick the caterpillars and irrigate the crop, as a poisoned bait was of no avail. It is gratifying to note the cultivators worked hard to stamp out the pest.

Pulse seeds attacked by pulse beetles (*Bruchus* spp.) were fumigated with carbon bisulphide. A number of termites, ... nests were fumigated with white ant powder.

Assam.—Work on the control of the cutworms (*Agrotis ypsilon*) on the onion crops of South Habiganj was continued with two Andres Maire traps at Khorki and Katora and the results thus far achieved have made a favourable impression on the cultivators.

Rice case-worm, Rice *Hispa*, stem-borers and grass-hoppers were general pests reported from both the Valleys. Army worm caterpillars appeared in the Karimganj Farm but were taken in hand in time and effectively controlled. A serious outbreak of caterpillar pests on Job's tears was reported from the Naga Hills; the Entomological Assistant proceeded to the localities affected and carried on spraying campaigns with considerable success. A Melolonthid beetle grub was reported to have caused heavy damage to the sugarcane crop of the Tezpur Jail. It was inquired into and remedial measures were suggested.

Burma.—Investigation of the paddy showed that borers caused little damage to the main crops; a trial of checking damage to a local *Mayin* crop by late cultivation proved successful.

Baited earthen pot traps proved successful against crabs (*Potamon dayanum*) in paddy fields.

Diacrisia obliqua was the only serious pest of dry-land crops, beans, sesamum, etc.

Investigation of cotton pests showed that early sowing evaded the pests to such an extent that very little damage was done.

Propaganda against the Palm Beetles were undertaken by posters and meetings.

Satisfactory progress was made in sericulture, the number of rearers increasing.

Bihar and Orissa.—Only routine work was carried out up to 31st March 1923 when Entomological Section was closed down.

Punjab.—Particular attention was devoted to the parasites of *Earias insulana* and 13 different species were found and their life-histories worked out. The attack of "Pink bollworm" (*Platyedra gossypiella*) was considerable in some localities (*e.g.*, Sialkot and Ferozpur); a sample of lint and seed from Sialkot weighing 373 tolas contained 370 living caterpillars. Cotton stem borer (*Sphenoptera gossypii*) was quite serious, in some cases 51·5% of the sticks being attacked; removal and subsequent burning of attacked sticks was quite effective.

As a result of the study of stubbles and dead hearts of Sugarcane, Maize and *juar* throughout the Province it has been established (*a*) that *Chilo simplex*, Butl., is mainly found in *juar* and maize, (*b*) that insects damaging sugarcane only are *Diatræa auricilia*, *Emmalocera sp.*, and *Scirpophaga sp.* The idea of using maize as a trap crop for sugarcane is therefore no longer tenable and the only solution is the safe disposal of the stubbles in which the borers have been seen to hibernate until March. Light trap experiments were continued and the observations on sugarcane moth borers attracted to light recorded.

There has been a serious outbreak of Citrus Psylla (*Euphalerus citri*) and Aleyrodidae (*Dialeurodes citri*) last year. Spraying was quite effective against the Psylla. As regards the Aleyrodidae they can only be killed after three or four operations. Crude oil emulsion or tobacco decoction have been found to be the most effective insecticides.

Mangohopper (*Idiocerusatkinsoni* and *I. clypealis*) were not very serious. The life-history of *I. atkinsoni* was worked out.

For stored grain pests superheating has proved to be a very effective and economical way of "cleaning" insect infested godowns. Experiments on air-tight storage have not so far yielded results of practical utility.

Study of the parasites of crop-pests was continued, and about 31 parasites of different crop-pests were bred in the laboratory. Two species of egg-parasites of *Euproctis fraterna, Mo.* were reared in the laboratory for many generations. Parasites and hyper-parasites of *Euphalerus citri* were observed and the life-cycle of parasites was worked out in detail. During March and

April larvæ and pupæ of *Coccinella punctata* and *Adonia doubledayi*, Muls., were found to be heavily parasitized by small Chalcidids.

Rats were very serious everywhere. Poisoning and fumigation gave satisfactory results. A systematic use of poisoned baits over large areas coupled with co-operation is the best and cheapest means of rat eradication.

North-West Frontier Province.—The Agricultural Station orchards are regularly sprayed, and the fruit growers, now realizing that good fruit cannot be produced without spraying, are showing willingness to spray. The proprietary insecticide called "Katakilla" is still the most satisfactory spray which has been tested at Peshawar. The orchards are not sprayed with it but branches which are affected by aphids or other insects are sprayed.

The olive fruit fly has not yet appeared in the Tarnab grove.

III.—Native States.

Mysore.—The usual campaign against *Kamblihulas* (*Amsacta albistriga*) resulted in the destruction of 270,299 moths representing 135 million caterpillars.

The new remedy devised against the sugarcane borers (*i.e., putting out small heaps of cane-trash to trap the moths*) has been tested more extensively and with better results than last year.

An interesting principle of control of hard-bodied insects with soft bodied larvae has been found and efforts on the lines suggested by it are now being directed against *Oryctes rhinoceros*. The presence of mercury in a small muslin bag hanging from the lids of jars containing pickles has been found effective against pickle-flies (*Drosophila* sp.).

Other investigations related to Mango-hoppers (*Idiocerus* spp.), Coffee Borer (*Xylotrechus quadripes*), Lime-tree Borer (*Chloridolum alcomene*) and Cotton Boll Worms (*Earias* spp.)

Travancore.—The coconut leaf-roller pest (*Nephantis serinopa*) made its appearance on several trees during the year and extra hands were engaged as fieldmen to induce the owners to cut and burn the affected fronds. On the whole 30,227 trees were so treated and the pest has now practically disappeared from many localities.

There was an outbreak of the rice swarming caterpillar pest [presumably *Spodoptera mauritia*] at Kuttanad, one of the chief rice growing centres of the State ; a detailed study of the life-cycle of this pest was made during the year.

The rice stem-borer pest and the ginger borer pest were carefully studied both in the field and in the laboratory. Pests like the rice case worm and rice bug also received attention.

IV.—Other Work.

Indian Tea Association.—Work has been mainly directed to *Helopeltis theivora*, the so-called mosquito-blight of tea, on which the Entomologist has published a very detailed monograph during the year.

ZOOLOGY

II.—ECONOMIC ZOOLOGY

Part II.—Forest Entomology

BY

C. F. C. BEESON, D.Sc., F.E.S., I.F.S.

(1) *Forest Entomologist.*

The year 1922-23 was relatively unfavourable for progress on the biologic and economic sides of forest entomology, owing to the uncertain financial position of the Branch and the indecision as to its future. The writer was absent on four and a half months leave and no technical officer was appointed in the vacancy. In systematics results have been more satisfactory.

Insects of sal.—(*a*) The large heart-wood borer: In Thano forest near Dehra Dun the separate enumeration of sal trees attacked by *Hoplocerambyx spinicornis* has been continued with a yield of 4,411 for the season 1922-23. This quantity represents the recognisable portion of the attack of 1922 plus the over-looked portion of the attack of 1921. As the markings must be carried out at the end of the rains, when the attack is not fully developed, some of the less heavily attacked trees are not detected, until after their death in the following year. The annual yields obtained since 1916-17 are as follows :—6,772 ; 10,190 ; 23,545 ; *nil* ; 3,855 ; 5,821 ; 4,411. As these figures do not represent the actual annual attack an attempt has been made to arrive at the correct values ; these appear to be 8,000 for 1920, 4,000 for 1921 and 2,500 for 1922. In the period 1920-21 control measures were instituted, the effect of which would first be visible in the attack of 1921. Since the rainfall has annually been increasing since 1919 it is believed that its effect has been counteracted by the remedial measures, and that the epidemic is now completely under control.

An attempt to estimate the financial loss due to the attacks of the borer has not been successful owing to the great fluctuations in the prices realised at timber auctions for clean and damaged timber, and absence of any basis for comparison. Moreover it does not seem possible to arrive at an idea of the sylvicultural damage, although a revision of the working plan is in progress.

The Thano borer outbreak illustrates very aptly the present position of forest insect control in India. The entomological side of the problem starts

with the application of general principles based on the forest entomology of Europe and North America, which soon give place to new conceptions arising from acquaintance with local conditions. The control measures suggested are mainly theoretical, and, as they necessarily involve extraordinary expenditure or departure from routine, are adopted by the departmental executive with reluctance. If applied thoroughly the results are measurable with great difficulty, and, finally, if the control measures can be demonstrated as successful, the cost of application and the value of the damage prevented cannot be calculated.

(*b*) In the laboratory and insectary experiments were conducted on the emergence period of the borer and length of life, etc., under varying conditions of temperature and humidity. Owing to the absence of the Forest Entomologist and the employment of the Upper Grade Assistants on educational work the results were unsatisfactory.

(*c*) A survey of the borers of sal with reference to their geographical distribution and alternate food-trees was made. In the families Scolytidae, Platypodidæ, Curculionidæ, Brenthidæ, Anthribidæ, Bostrychidæ and Longicornia over sixty species are identified as sal borers, of these 45% occur also in the Malay Archipelago, 60% in Indo-China, 100% in Assam and Bengal, 85% in the submontane region of the United Provinces, 57% in Central India, 38% in South India and Ceylon, while 27% are extra-oriental. These results are sufficient to show that the study of the borers of *Shorea robusta* cannot be restricted to conditions in the sal habitat, but involves other forest types and timber species elsewhere in British India. Very few species are confined to sal, or to parts of its habitat, and these monophagous species are not necessarily important as pests. The composition of the borer-fauna at any part of its habitat is a function of the locality, *i.e.*, the ecological conditions of the environment are of greater importance in deciding what species of borers occur than in the presence of sal as a food-supply.

Insects of Teak.—Teak insects have received no attention during the year. The special investigation of the beehole borer carried on by Mr. J. M. D. Mackenzie was concluded by his departure on six months leave, and by the decision of the Government of Burma not to re-open the enquiry. The chief results obtained from the enquiry are :—(1) the abundance of the pest varies greatly in neighbouring areas and in successive years ; (2) natural control factors periodically bring the local annual incidence almost to zero, but on the whole the mean annual incidence slowly increases ; (3) the increase is relatively greater in the past 20-30 years in both plantations and natural forest, but there are indications of a general decrease quite recently.

No explanations of universal application can be given for the fluctuation in abundance, and, in particular, the correlation of fire-protection with the conditions mentioned in (3) is neither proved nor disproved. The sylvicultural schemes providing for early and frequent thinnings in plantations, etc., afford a means of producing periodic reductions in the abundance of the pest, and there is reason to believe that large clearances for regeneration can be utilised to afford a heavy initial check.

Future investigations should determine the comparative effect of thinnings, the possibility of retarding the infestation of concentrated regeneration areas, the value of alternate hosts as trap-crops and the effect of fires. The value of the work already done on this pest is much invalidated by the absence of reliable historical records for the forests sampled, and we are therefore compelled to wait for the future to supply accurate histories. Until a wholetime investigator is available to maintain continuous observations no progress can be anticipated. Meanwhile some thousands of acres of teak regeneration are being formed annually in which the pest is establishing itself with far greater rapidity than it did in the nineteenth century.

Miscellaneous pests.—*The Borers of timber under seasoning.* Work on this subject was continued in the Insectary, with special attention to dry wood borers of the type of *Stromatium barbatum*. About 9,000 specimens of insects were reared in the Insectary.

(2) *Systematic Entomology.*

The Insect Collection.—The growth of the collection of forest insects during the year excelled previous records. A total of 752 species not previously represented was added, including 26 novelties that are represented either by types or by cotypes. Nearly 16,000 specimens were mounted and labelled, of which 6,235 specimens were sent abroad to specialists for determination. The entomologists who have given their services on behalf of the Institute are Drs. Arrow, Blair, Marshall and Obenberger, Messrs. Andrews and Champion, Mons. Fleutiaux, Desbordes and Lesne, Herrn Kleine, Corporaal, and Col. Winn Sampson for *Coleoptera ;* Dr. Waterston, Messrs. Crawley and Turner and Rev. Morice for *Hymenoptera ;* Messrs. Tothill and Senior-White, and Miss Ricardo for *Diptera ;* M. Esben-Petersen for *Neuroptera ;* Prof. Silvestri for *Isoptera ;* Major Fraser for *Odonata ;* Messrs. Fletcher, Meyrick and Tams for *Lepidoptera ;* Mr. Green for *Homoptera.*

Dr. Cameron has worked especially at the revision and expansion of the following families :—*Staphylinidæ, Erotylidæ, Endomychidæ, Cloydiidæ, Elateridæ, Tenebrionidæ, Brenthidæ, Nymphalidæ, Papilionidæ, Pieridæ,* and *Chalcidæ ;* Dr. Beeson has dealt with the *Scolytidæ, Platypodidæ* and *Bostrychidæ ;* Babu Soilendra Nath Chatterjee has been mainly responsible for the revision of the *Rhopalocera.* In all over 12,000 specimens of identified insects have been added to the collection in the last twelve months. Exchange of material has been effected between the Institute and foreign entomologists, and other scientific institutions in India, Europe and America.

For the accommodation of the growing collection ten 20-drawer store-cabinets and 227 store-boxes were obtained—a very inadequate equipment due to the rigorously enforced economy in new stores.

General Review of Systematic Work.—Advance on the systematic side of forest entomology during the last two years has been the most satisfactory feature of research, but progress has received a serious check by

the breakdown in health of Dr. Cameron necessitating his departure from India at the close of the year under review.

Dr. Cameron commenced work on 4th December 1920. During the two and a quarter years that systematics have received adequate attention 1,786 new species have been acquired (as against 190 species in the previous three years, 1917-1920), and about 25,000 specimens have been named and incorporated.

VETERINARY SCIENCE

BY

J. T. EDWARDS,

Director, Imperial Bacteriological (Veterinary) Laboratory, Muktesar.

I.—Imperial Bacteriological Laboratory, Muktesar.

Rinderpest.—As this represents the most serious single disease condition in animals in India the problem of its origin, nature, and immunology was attacked on a large scale, and the available resources of the laboratory were devoted mainly to its intensive study. Results of far-reaching importance were obtained concerning the properties of the virus, its probable nature, transmissibility to experimental animals (notably the rabbit, by blood "passage,") and the effects of exaltation and attenuation. Numerous experiments were conducted upon methods of anti-serum production. Work upon this disease is still in active progress and it is not proposed to make definitive announcements until the results already obtained have been confirmed and elaborated, when the records will be collected in the form of a memoir for publication.

Haemorrhagic septicaemia of Cattle.—Systematic observations and experimental tests undertaken on the larger animals furnished evidence upon the efficacy of the biological products (vaccines and sera) now issued from the laboratory for preventive treatment in the field. Further work in this direction is in progress. The results are reassuring, in view of the discredit that appeared to have been thrown by certain American workers upon vaccine treatment as the outcome of experimental tests upon small laboratory animals.

Contagious abortion in mares and cows.—Agglutination tests were performed systematically at the laboratory upon sera obtained from important breeding studs in the Punjab with a view to obtaining evidence regarding the incidence of the common form of equine contagious abortion, and the possibility of arresting the spread of the disease by the segregation of carriers. Attempts were made at the laboratory to evolve a satisfactory method of vaccination. The economically most important disease of breeding cattle in Western Countries—contagious abortion—was detected in certain large Government dairy herds in India, measures were taken for the systematic testing of these herds to determine the incidence of the disease and arrangements were made to control its spread by segregation methods or by vaccination.

Mange.—Observations were made upon the life-history of the sarcopt of the buffalo, and the vulnerability of the various stages in its development with a view to obtaining knowledge upon a satisfactory system of acaricidal treatment. (A paper was read by Mr. T. M. Timoney, 3rd Bactoriologist, upon this subject at the 5th Entomological Conference held at Pusa in February 1923.)

East Coast Fever.—In the course of routine examinations for protozoan parasites at the laboratory six cases of infection in cattle with a parasite quite indistinguishable morphologically and in distribution in the tissues from *Theileria parva*, the causal agent of the formidable East Coast fever of cattle in Africa, were encountered within a period of one month (June-July 1922). The parasites did not appear to have caused any grave disorder, and attempts to transit them to susceptible animals failed.

Other bovine piroplasmosis.—Extremely numerous infections with *Theileria* (*Gonderia*) *mutans* were discovered, notably in smears taken from cattle after infection with rinderpest, and sometimes this parasite appeared capable *per se* of setting up serious, even fatal, disease. *Piroplasma* (*Babesia*) *bigeminum* was frequently detected.

Bovine coccidiosis.—Numerous cases of this affection were detected in cattle at the laboratory ; in fact, after the application of the finer methods of diagnosis it was difficult to obtain cattle which were not carriers of coccidia. It has been ascertained in other countries that resuscitation in virulency of this latent infection may prove a serious complication during the progress of an outbreak of rinderpest. It would appear that this phenomenon prevails in India to an extent hitherto unsuspected.

Trypanosomiasis.—Systematic attempts were made to discover a cheap, easily applicable and efficacious treatment of surra. It was found that in the more resistant host species such as cattle and buffaloes infection could be temporarily suppressed very readily by means of tartar emetic. In the more susceptible species such as the horse, a few tests indicated that intensive administration of a potent arsenical compound, tryparsamide, reported to be efficacious even in the treatment of human sleeping sickness (kindly supplied to the laboratory by the Rockefeller Institute), did not check the progress of the disease to such an extent that fatalities were suppressed.

" Nasal granuloma " of cattle.—Morbid specimens of this condition were received from Assam, Bihar and Orissa, and the Bombay Presidency ; the peculiar granular formations resembling " actinomyces " granules were detected in the lesions, and attempts were made to elucidate their nature.

Strangles.—The possibility of controlling this affection among horses at Army Remount Depôts was studied, and sero-vaccination undertaken systematically at certain depôts. This work will have to be continued for some time to come in order to obtain satisfactory information with regard to the value of the treatment.

Diseases of young stock.—The organisms responsible for certain affections (" joint-ill," " naval-ill," diarrhoea, and early mortality) among foals,

particularly, in certain parts of India were studied. Among various organisms isolated may be mentioned a strain which was found to be indistinguishable from *Bacillus viscosum-equi*, the common cause of pyaemic nephritis of foals in Europe.

A number of experimental tests was made upon material received from an enzootic pleuro-pneumonia of young sheep in Madras.

A considerable number of interesting specimens of minor interest was studied, and advice tendered to officers of the R. A. V. C. and I. V. S. on technical problems.

Systematic training of officers of the Provincial grade of the I. V. S. selected for promotion to Imperial rank (two years' course) and of officers of the R. A. V. C. and I. V. S. (short summer courses) was given in the methods of animal disease investigation.

II.—Camel specialist, Sohawa, Punjab.

(*a*) It is claimed that investigations upon the treatment of surra in camels by means of tartar emetic have demonstrated conclusively the efficacy of this drug as a curative agent. Treatment has been carried out on a large scale by the military authorities in India and Aden with very satisfactory results, according to the reports received from officers of the R. A. V. C. This has resulted in a saving to Government amounting to several lakhs of rupees during the financial year.

(*b*) Transmission of surra by different varieties of biting flies was demonstrated and by a newly discovered species of tick *Ornithodorus crossii* Brumpt. The discovery of the transmissibility of trypanosomiasis by means of ticks is of great interest, for it is quite possible that human trypanosomiasis (sleeping sickness) in Africa may be transmitted in the same manner.

(*c*) The fly *Hypoderma crossii* Patton, the cause of "warbled" hides in goats, was bred out and methods suggested to reduce the damage caused by this fly. The economic loss caused by the damage to hides is very great: a firm of hide importers in England reported that one-fourth of the hides from Karachi were damaged to the extent of 60 to 70 per cent. of their value. Many thousands of goats and cattle from Pindi to Delhi were examined and the percentage of cattle found infected was very high. On the other hand, infection was only detected in goats maintained in hilly districts, whilst cattle were found infected both in hilly districts and on the plains. In England the loss caused by the warble flies to dairy cattle has been calculated at £3 per head. The loss caused by the fly in Punjab must therefore be enormous in view of the number of cattle and goats kept, when account is taken both of the damage to the hides of these animals and the deterioration in productive value of the dairy cattle.

(*d*) A survey of the biting flies and other arthropods of the Punjab is being undertaken. This has resulted in the discovery of

(*i*) the fly *Hypoderma crossii* Patton causing warbles in goats,

(*ii*) a new species of tick *Ornithodorous crossii* Brumpt,

(*iii*) a new species of "bot" fly, hitherto unnamed, bred from the nasal cavities of the oorial (wild sheep).

Tabanus suflies Jaenaeke and *Ornithodorus savignyi* have been identified for the first time in the Punjab, and a large number of new species of Tabanidæ (hitherto unnamed) has been collected.

(*e*) It was ascertained that heavy losses occurred during the year amongst poultry from spirochaetosis. These losses might have been reduced by 95 per cent. if the owners had adopted the treatment recommended.

(*f*) Heavy losses in animals due to surra occurred during the year along the Deg Nalla. This area is probably the worst affected zone in the Punjab.

III.—Punjab Veterinary College, Lahore.

(*a*) Prophylactic inoculation against rabies in dogs has now been undertaken successfully for the past eight years by Mr. Taylor, Professor of Pathology, and the results obtained warrant the conclusion that the method employed may now be safely applied in general practice. Out of 321 dogs treated in this manner at the Hospital, 13 developed rabies during the progress of the treatment and only 7, or 2·3 per cent., developed rabies subsequent to the completion of the treatment.

(*b*) Experimental work was undertaken upon canine surra and as the results were encouraging it is proposed to continue the work during the next cold weather.

(*c*) Some experimental tests upon the so-called "deficiency" diseases were carried out by Captain Sewell upon horses, pigeons, and rabbits. The results are promising and further work in this direction is in progress.

(*d*) During the past two years S. Hardit Singh has been engaged in preparing dissection specimens for the anatomical museum, and sixty-one specimens have already been mounted.

IV.—Government Cattle Farm, Hissar, Punjab.

The following scientific publications were prepared during the year :—

(*a*) A note on Haemorrhagic Septicaemia, by R. Branford, M.R.C.V.S., to be published as a leaflet by the Director of Agriculture, Punjab.

(*b*) A note on Ensilage made from Sheesham leaves, by Captain Sewell, M.R.C.V.S., published in the now defuct *Industrial Bulletin.*

(*c*) A note on Johne's Disease, by Captain Sewell, published in the *Agricultural Journal of India*, Vol. XVII.

V.—Madras Veterinary College.

(*a*) Investigations were conducted on the disease conditions known as Nasal Granuloma and Infectious Lymphangitis affecting cattle in the Presi-

dency. These investigations formed the subject matter of two papers read by M. R. Ry. V. Krishnamurthy Ayyar Avergal, Professor of Pathology in the College, at the Second Veterinary Conference held at Calcutta in February 1923. Abstracts of these papers are being published as appendices to the Report of the Proceedings of the Conference.

(*b*) Work was carried out upon the preventive inoculation of dogs against rabies, in collaboration with Colonel Cornwall, of the Pasteur Institute, Conoor.

(*c*) A systematic collection and classification of worm parasites and flies affecting animals in the Presidency was attempted. It is of interest to find that the fly *Cobboldia elephantis* exists in Southern India, and its identification was confirmed by the Imperial Entomologist.

VI.—Bombay Veterinary College.

Specimens (smears and sections of lung) received from a cow that had succumbed at Nasik, in October 1922, disclosed conclusive evidence of infection with advanced bovine tuberculosis. This case is of particular interest as it represents what appears to be the first record of a condition occurring in Bombay Presidency indistinguishable from bovine tuberculosis as it is known to occur elsewhere. (*Vide* Bovine Tuberculosis in the Bombay Presidency by M. H. Sowerby, I.C.V.D., *Indian Journal of Medical Research*, 1923, April, Vol. 10, No. 4, pages 1169—1171.)

VII.—Miscellaneous.

Information from the Provinces shows that elsewhere the efforts of the veterinary staffs were not specially diverted to scientific research. Much valuable knowledge is, however, to be obtained from the records of observation and treatment of animal disease in the field in the Annual Reports of the several Provinces. The Veterinary Adviser to Government, Central Provinces, calls attention to the information contained in the proof-copy of his Annual Report for the year under report. It is of considerable interest to note that the most serious epizootic disease of cattle in India, rinderpest, displayed remarkably low virulence during the year and showed little tendency to spread from the few centres in which it appeared. An instructive chart is published in the report illustrating the seasonal incidence of the more serious epizootics : it is of considerable interest to note that rinderpest and foot and mouth disease display their highest degrees of severity at opposite seasons of the year. The reported incidence of anthrax, over 2,000 cases, was high, but it is admitted that it represents only a relatively low proportion of the total incidence. Much valuable information was obtained by systematic examination of a large number of blood smears and other morbid material.

MEDICAL RESEARCH

BY

The HON'BLE MAJOR-GENERAL R. CHARLES MACWATT, C.I.E., M.B., F.R.C.S., K.H.S., I.M.S.,

Director-General, Indian Medical Service.

The following is an extract from the Annual Report of the Scientific Advisory Board of the Indian Research Fund Association for the year 1922-23.

* * * * * * *

Leprosy.—Dr. E. Muir summarises progress as follows :—

1. Encouraging results have been obtained in treatment with the ethyl ester of various fatty acids, especially with those derived from the oils of certain trees—notably Chaulmoogra and hydnocarpus oils.
2. The effect of these esters in treatment is being compared with that of linseed ester.
3. Experiments have led to the elimination of the irritating property of the esters, so that administration is now accompanied with a minimum of pain.
4. The efficacy of various other drugs and vaccines in treatment has been tested.
5. An attempt to infect laboratory animals with leprosy has so far met with no success.
6. A histological examination of the various lesions found in leprosy has been made.
7. An investigation is being made into the ferment responsible for the breaking of bacilli in the tissues which takes place under treatment and also spontaneously under certain circumstances.
8. The reason for the positive Wasserman reaction in so many cases of leprosy is under enquiry.
9. The relative infectiousness of pauper and non-pauper lepers is being examined with a view to ascertain the possibility of elimination of spread of infection by compulsory segregation of pauper lepers.

In connection with the above, valuable results have been obtained by Dr. Nishi Kanta De, who is working in the chemistry of drugs used in treatment and of the blood of lepers and resistant animals.

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Cancer.—Dr. K. K. Chatterji continued his examination of the efficacy of Margosate Oil and its derivatives in treatment.

Influenza.—Major King, I.M.S., examined statistically the records of vaccinations against Influenza, and found the evidence relating to its efficacy to be inconclusive.

Pneumonia.—Captain Malone, I.M.S., with the co-operation of the Military Authorities conducted in Quetta a further trial into the efficacy of anti-pneumococcic vaccine. The results are being examined statistically.

Captain Malone also tested the efficacy of a therapeutic vaccine in the treatment of cases, and grouped, according to type, the pneumococcic isolated from patients.

Deficiency Diseases.—In addition to very valuable work in connexion with the histology and pathology of these diseases Lt.-Colonel McCarrison, C.I.E., I.M.S., has been experimenting in collaboration with the Agricultural Chemist, Madras, on the vitamin value of 12 different samples of rice grown under known conditions of soil and manurage, and on the value of ragi grown by the Agricultural Department on experimental plots of known composition and manurage.

Other experiments in progress are :—

(*a*) The Nutrition value of Dal as a substitute for meat.

(*b*) The types of disease resulting from the too exclusive use of various rices commonly eaten in India.

(*c*) The effect of the development of certain toxins in rice during storage.

Revision of Indian Culicidae.—Captain Barraud has completed eight papers for publication, and in them has described many species new to science. When work on all the genera is finished the complete revision will prove of inestimable value to future workers in mosquito-borne diseases.

Kala-Azar.—Work has been carried out on the following lines :—

(*a*) Treatment of cases in the special research hospital. Promising results have been obtained.

(*b*) Investigation into the method of transmission of infection. The main heads of this branch of the enquiry are :—

(1) An entomological survey of infected and uninfected areas.

(2) The examination of various insects with a view to the discovery of definite stages in development after injection of the parasite.

(3) The examination by cultural methods of wild specimens of the bed bug to see if such specimens ever contain living forms of the parasite.

(4) Transmission of the disease to laboratory animals.

(3) Examination of excreta of human patients to ascertain if the parasite ever leaves the human body therein. Major Shortt, I.M.S., has succeeded in proving that the living parasite is in some cases contained in the urine.

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In connexion with the work in Assam Mr. C. M. Hutchinson, C.I.E., is preparing specimens showing the normal cytology of insects :—an obvious preliminary to the study of pathological conditions.

Dr. Brahmachari continued his research into the chemotherapy of antimonial compounds used in treatment of Kala-Azar. His preparations are tested in the research hospital, Shillong. With one, Urea Stibamine, very promising results were at first obtained.

Malaria.—Major J. A. Sinton, V.C., O.B.E., I.M.S., investigated the action of quinine in treatment. By administering the drug in combination with alkali he has brought forward evidence that a comparatively small amount of quinine is sufficient to cure the paroxysm. He is now investigating the comparative liability of persons so treated to relapses.

Major H. W. Acton, I.M.S., continued his researches into the efficacy of cinchona alkaloids and compounds in treatment.

The Reverend Father Caius was engaged in the chemical analysis of quinine and cinchona alkaloids.

Ankylostomiasis.—The enquiry under Dr. K. S. Mhaskar in co-operation with the Reverend Father Caius terminated on 27th January 1923. Further work in relation to the diagnosis of hook-worm infection is being carried out at the King Institute of Preventive Medicine, Guindy.

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Lathyrism.—The three aspects of this enquiry, chemical, botanical and pharmacological are being investigated in co-ordination by Dr. J. L. Simonsen of the Forest Research Institute, Mr. A. Howard, Imperial Economic Botanist and Captain L. A. P. Anderson, I.M.S., at the Central Research Institute, Kasauli.

Results have been obtained which promise to solve the cause of the disease and lead to the introduction of simple methods for its prevention.

Antivenin.—The Reverend Father Caius continued this enquiry, which has for its object the concentration of the serum in order to over-come to disadvantages attaching to a bulky dose.

Composition of the River Waters in Bengal.—Work was continued by Rao Sahib Govinda Raju throughout the year on the lines reported last year.

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Entomological Section of the Central Research Institute, Kasauli.—As stated last year the cost of this section was borne by the Indian Research Fund Association for the year under report.

The training of Sub-Assistant Surgeons and laboratory attendants was continued during this year under and at the cost of the Indian Research Fund Association.

Indian Journal of Medical Research.—This Journal has just completed its 10th year of existence.

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Departmental Publications.

I.—Meteorological Department—

Government of India Office.

(1) The Indian Daily Weather Report and Chart.

(2) The Weekly Rainfall Summary.

(3) The Monthly Weather Review.

(4) The Annual Summary.

(5) The Rainfall of India.

(6) Indian Meteorological Memoirs.

Bengal Office.

(1) Bengal Daily Weather Report and Chart.

(2) Monthly Rainfall Tables and Summaries of the chief feature of the weather of the month over Bengal.

Bombay Office.

(1) Bombay Daily Weather Report and Chait.

(2) Monthly Abstracts of the Bombay observations (*Bombay Gazette*).

Madras Office.

(1) Bombay Daily Weather Report and Chart.

(2) Monthly Rainfall Tables (*Madras Gazette*).

Allahabad Office.

(1) Monthly Weather Summaries (*United Provinces Gazette*).

(2) Annual Summary.

(3) Monthly Rainfall Tables (*United Provinces Gazette*).

Lahore (Simla) Office.

(1) Monthly Summary }
(2) Annual Summary } of Punjab weather.

II.—Geological Survey.

The publications of the Department include—

Palæontologia Indica arranged in series, and sold in parts which are priced at 4 annas (6 pence) per plate.

Memoirs, Vols. I—XLV, including the larger papers on geological subjects.

Records, Vols. I—L, including the shorter papers and Annual Reports from 1868 to 1915 sold in parts, priced one rupee each.

Manual, Guides and Maps.

A complete list of the contents of these publications can be obtained by application to the Registrar, Geological Survey of India, 27, Chowringhee Road, Calcutta.

Indexes to the Genera and Species described in the *Palæontologia Indica* up to 1891, to the Memoirs, Vols. I—XX, and to the Records, Vols. I—XXX, have been printed for sale.

III.—Survey of India.

(1) Annual General Report.

(2) Professional Papers.

IV.—Botanical Survey and Royal Botanic Garden, Calcutta.

(1) Annual Report of the Botanical Survey of India.

(2) Records of the Botanical Survey, Vols. I—X.

(3) Annual Report of the Industrial Section, Indian Museum.

(4) Annual Report of the Royal Botanic Garden, Calcutta.

(5) Annals of the Royal Botanic Garden, Calcutta, Vols. I—XII, Part II.

A list of the contents of the Records and of the Annals with prices of the numbers and volumes still available can be obtained by applying to the Superintendent, Royal Botanic Garden, Calcutta.

V.—Department of Agriculture.

(1) Annual Report.—An account of the year's work of the Imperial Department, including the separate reports of the scientific officers of each branch (Agricultural Chemistry, Botany, Mycology, Entomology, and the like).

(2) The Agricultural Journal of India.—A quarterly journal containing articles on agricultural matters intended for the educated agriculturist and the general reader interested in agriculture.

(3) Scientific Memoirs of the Department of Agriculture.—An occasional publication for papers of a scientific or technical nature divided into series such as Chemical, Botanical, Entomological, and the like.

(4) Bulletin.—An occasional publication containing information on agricultural matters of a temporary nature.

(5) Leaflets.—Short notes of practical instruction in agricultural matters, dealing mainly with Entomological subjects.

VI.—Forest Department.

(1) Review of Forest Administration in British India by the Inspector-General of Forests (issued annually).

(2) Annual Progress Report of Forest Administration in each Province.—Issued by the Local Governments annually.

(3) Indian Forest Records.

(4) Indian Forest Memoirs.

(5) The Indian Forester.—A monthly Journal of Foresty, Agriculture, Shikar and Travel. This is a Departmental Journal, Published monthly.

(6) Bulletins are published from time to time.

VII.—Zoological Department.

(1) The Annual Report, 8vo.

(2) Records of the Indian Museum, 8vo. Containing short papers on Indian Zoology. One or two volumes issued annually in quarterly parts.

(3) The Memoirs of the Indian Museum, 4to. Containing monographs and other important papers. Published at irregular intervals.

(4) Descriptive Catalogue of Indian Decapod Crustacea, 4to. Parts published at irregular intervals.

(5) Descriptive Catalogue of Indian Echinodermata, 4to. Parts published at irregular intervals.

VIII.—Civil Veterinary Department.

(1) Annual Report.

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